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Power for Heavy Machinery Factory

INDUSTRIAL PLANT EQUIPPED WITH MODERN MACHINERY AND APPLIANCES FOR KEEPING CONTINUOUS AUTOMATIC RECORDS

THE MANUFACTURE OF heavy sawmill machinery was carried on for many years by the Clark Bros. Co., in Belmont, N. Y.; but its factory was practically destroyed by fire about 2 yr. ago and a new factory has been built in Olean which is modern in every respect and fireproof throughout. The layout of the buildings is such that as business increases the capacity can be doubled without in any way interfering with the efficient working of the factory.

Steam is generated at 150 lb. pressure in Stirling boilers of which there are 2 in the setting, each with a capacity of 300 hp. One boiler is sufficient to handle the load at present and it is provided with Jones underfeed stokers; the boiler held in reserve is hand-fired.

Coal is delivered to the boiler room in drop bottom cars on a track supported on beams 7 ft. above the boiler room floor. There is storage room under the track for 200 tons of coal. As the coal is being fed to the furnaces the amount used is tallied by a registering device on the stoker. From the pattern shop sawdust

FIG. 3. GENERAL VIEW IN THE ENGINE ROOM

Power required by this factory is not a great deal, but the buildings which cover considerable space must be heated, and after careful estimates were made it was decided to build and equip an isolated power plant to furnish light, heat and power for the entire factory.

and shavings are blown to the roof of the power plant and discharged through a cyclone head to the floor of the boiler room.

To insure proper combustion, forced draft is used which is furnished by a fan driven by the stoker en-

gine; the arrangement of the air ducts is shown in Fig. 1. This illustration also shows the method of baffling the boiler and the spaces allowed for the passage of the

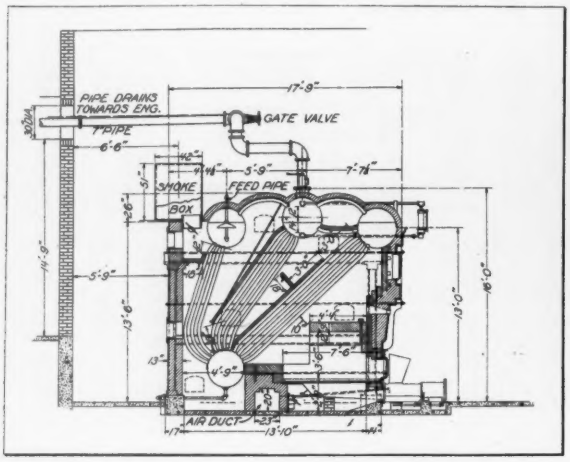


FIG. 1. CROSS SECTION OF BOILER SHOWING AIR DUCT AND BAFFLING

gases. The flue gases pass to a breeching running over the rear of the boilers, which conducts them to the brick stack with a diameter of 5 ft. and height 95 ft. above the grates.

Feed water is taken from the city mains and after passing through a Cochrane heater and purifier is fed at a temperature of 208 to 212 deg. to the boilers by a Fairbanks-Morse duplex packed plunger pump, 7 by 4½ by 7 in. The heater also acts as a receiver for the heating system, the condensate being delivered to the heater by a Blake & Knowles simplex vacuum pump, 8 by 10 by 12 in.

FIG. 2. VIEW IN BOILER ROOM

Purification of the make-up water is accomplished as it passes through the heater by feeding the proper chem-

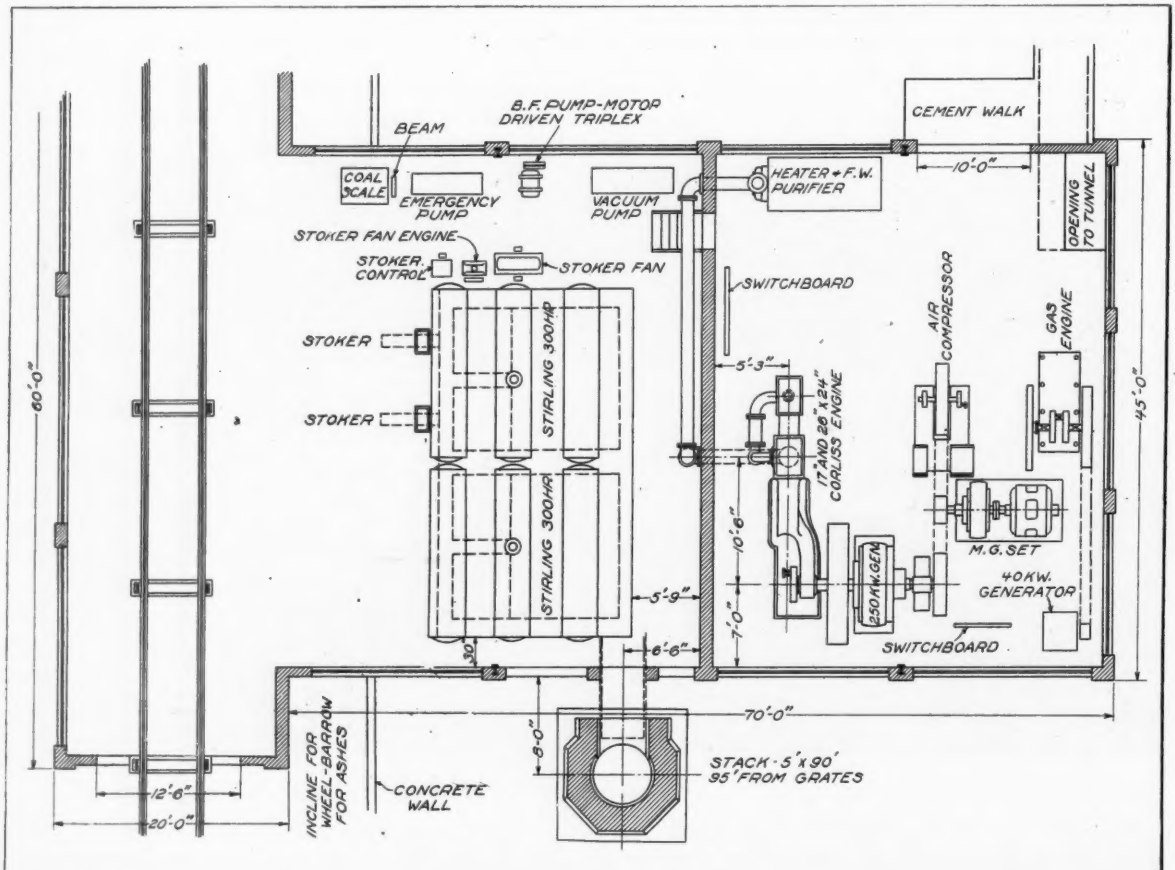


FIG. 4. PLAN OF THE POWER PLANT

icals in correct proportions to the inlet water. The heater is also equipped with a Lea V-notch meter so that a constant tally on the amount of water evaporated is kept automatically.

All exhaust steam from the engines and pump in the plant goes to the oil separator on the heater, then what is used by the heater is drawn in by induction; the remainder goes to the heating system during cold weather, at other times it passes to atmosphere. A Cochrane multiported back pressure valve is employed to give the required pressure on the heating system.

In the engine room the main unit is a Clark Bros. tandem compound Corliss engine, 17 and 26 by 24 in., direct-connected to a General Electric continuous current generator of 250 kw. capacity at 250 v., the unit being run at 150 r.p.m., and is provided with a flywheel.

An Ingersoll-Sergeant Drill Co., 2-stage air compressor, supplying air at 100 lb. pressure for various purposes about the factory, is driven by belt from a pulley on the shaft of the main unit. The dimensions of the compressor are 16 by 10 by 10 in.; an intercooler is placed in the base and the cylinders are water jacketed.

A motor generator set, to be used in case of emergency, will supply the necessary electric power and drive the air compressor when it is thought advisable to use central station current. This set consists of a 300-hp. synchronous motor run at 500 r.p.m., on 3-phase current of 25 cycles at 2200 v., and a 200-kw. d.c. generator developing current at 250 v. A separate 2-panel switchboard is used to control this set.

When the electric load is light, such as sometimes occurs nights, it is carried by a Clark gas engine belted to a 40-kw. G. E. d.c. generator running at 1200 r.p.m. and furnishing current at 250 v.

The main switchboard consists of but 3 panels—one for the gas engine driven generator, one for the main generator and one distributing panel and a swinging bracket supporting a voltmeter. Two ammeters indicate the load upon the generators and an integrating wattmeter gives the amount of power used. All instruments are products of the General Electric Co.

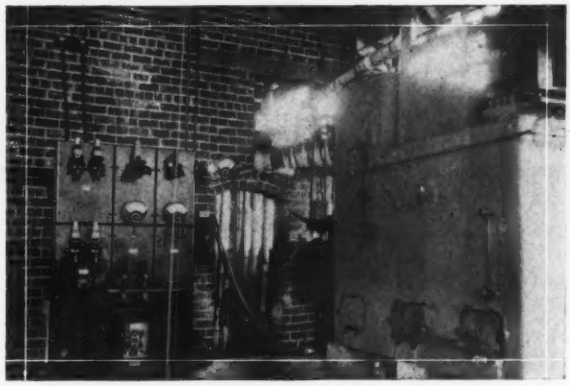


FIG. 6. MAIN SWITCHBOARD AND HEATER

As it is not intended to run the generators in parallel, a safety device has been put upon the switches to prevent those on the main generator leads from being closed when those on the small generator are closed. This consists of a small board with notches sawed in it so spaced that only one set of switches can be closed at once; it is clearly shown in Fig. 6.

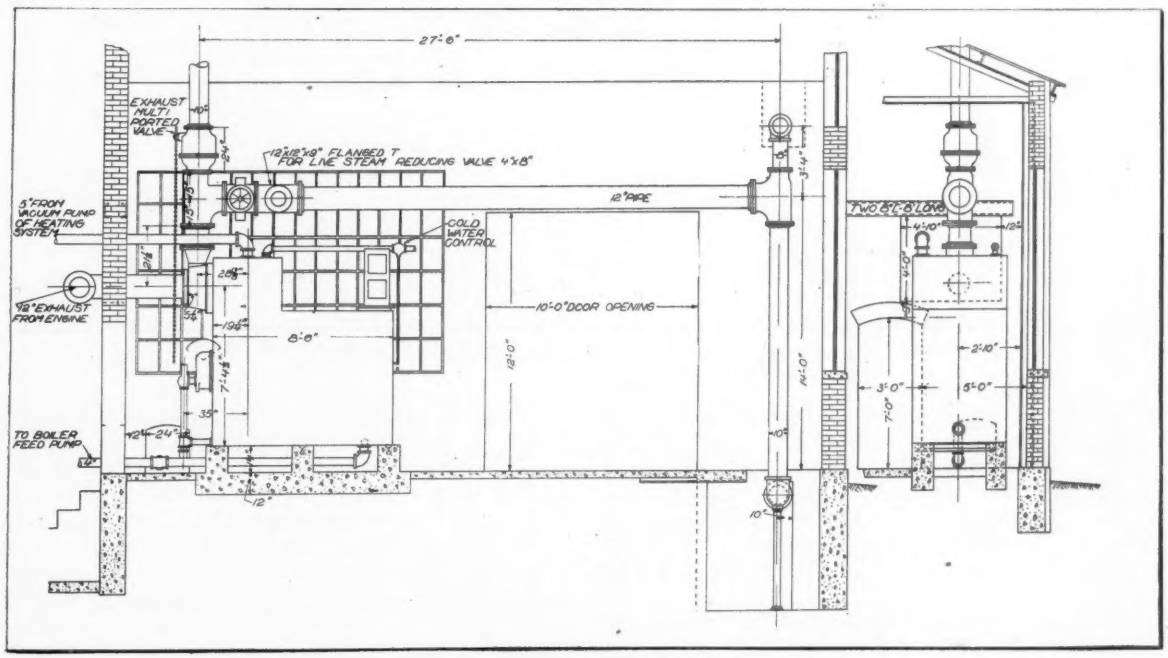


FIG. 5. HEATER PIPING

Heating of the entire factory is done by a Webster vacuum system using the exhaust steam from the power plant, all radiators being equipped with sylphon thermotors. It is estimated that 7200 lb. of steam are used per hour in zero weather for heating, with an average temperature through the factory buildings of 65 deg.

From the power house all piping and transmission lines run to the various buildings in a tunnel, which is 4½ ft. wide by 6½ deep, inside dimensions, with concrete walls and ceiling; the floor, however, is sand and gravel, which drains any water that may leak from the pipes, and makes easy access to the sewer and fire service pipes, which are beneath the floor surface. The arrangement of the pipes and electric lines in the tunnel is shown in Fig. 7. To facilitate the hanging of pipes and wires, Coburn tracks are placed vertically at regular intervals in the cement walls, with openings top and bottom. Details of the method of using them are shown in the illustration, which also shows the scheme used for hanging the heating mains in the machine shop, which proved inexpensive and convenient.

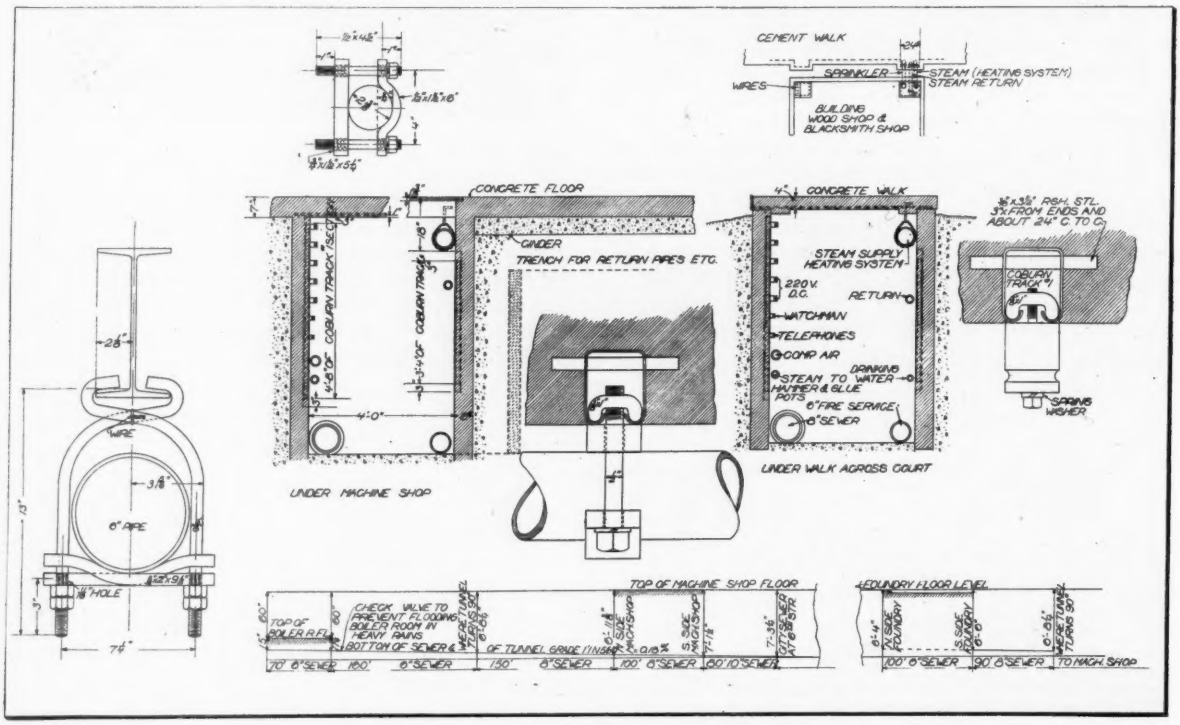


FIG. 7. DETAILS OF PIPE AND CABLE SUPPORTS IN TUNNEL

Estimates before the plant was built placed the cost of power which would be used at 1.51 c. per kw.-hr., including interest and depreciation charges, and for 4 days last June close account was taken of the expense to operate the plant under average conditions, which showed that the operating cost amounted to 0.96 c. per kw.-hr., not including interest and depreciation, a good showing for this size of plant.

One of the noteworthy features of this plant is the automatic system of record keeping. The strokes of the stoker have been calibrated and a stroke counter, read each day, gives means for estimating closely the amount of coal used. The Lea V-notch feed water meter records the amount of water fed to the boiler. The electrical output is read from the switchboard meter. Power required to operate the air compressor has been measured by running it with the motor generator and noting power required as indicated by the meter. This does not vary greatly from day to day, so an average is used in making up costs.

Taking readings once a day, an office clerk, with very little work, supplies the management with indisputable cost data on all power plant products with the exception of heat. A continuous record is the great need of most isolated plants and the simplicity of the system used in this plant will commend it to other similar plants.

WM. N. DAVIS has the following to say, in Machinery, on how to remove oil vapor from compressed air:

"As I have had to do with the lubrication of a great many air compressors in the work in which I am engaged, I would say that often more oil is used in the cylinders of compressors than is necessary. The compressed air is dry and there is no moisture to wash the oil off the surfaces as in the case of steam cylinders, and but little oil is needed to afford good lubrication. Vapor which arises from a large amount of oil in contact with the hot surfaces causes trouble. A smaller amount of oil, just enough to give good lubrication, would not give off an appreciable vapor. The oil used should be sufficiently high in flash point so that it will not give off an appreciable amount of vapor at the temperatures ordinarily obtained in air compressors.

"Two years ago, while reorganizing the lubricating practice of a large corporation, I found at one plant, where several air compressors were in use, that the chief engineer used no oil whatever in his air cylinders, but used soapsuds as a lubricant. The suds were made by dissolving a bar of hard soap in about 5 gal. of water, and were fed into the cylinder the same as oil."

Soot Blower Test

RESULTS, SHOWING GAIN IN EFFICIENCY BY USE OF MECHANICAL BLOWER. BY J. A. MOYER

RECENTLY a series of tests was conducted on a 250-hp. Babcock & Wilcox water-tube boiler in the power plant at the Pennsylvania State College to determine the efficiency and evaporation of the boiler when using a mechanically-operated soot blower of the type illustrated in Figs. 1 and 2, with the object of comparing the results with those obtained when the soot was removed from the boiler tubes with a steam nozzle operated by hand.

The greatest obstacle to the proper conduction of heat is soot, a product formed from imperfect combustion, and composed of finely divided carbon and mineral ingredients. Under ordinary conditions, it cannot be prevented from accumulating on the tubes of boilers, where it forms in spite of every practical precaution, and with any grade of fuel.

BLOWING METHODS

FORMERLY, the method employed for the cleaning of the exterior portion of tubes in the boiler in question was the use of a steam nozzle attached to the end of a

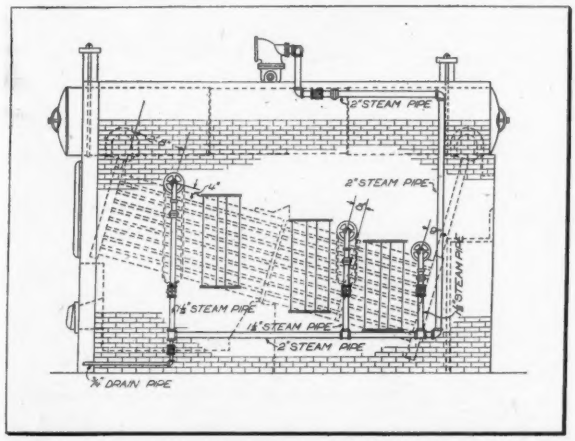


FIG. 1. LOCATION OF SOOT BLOWERS IN BOILER SETTINGS

flexible steam hose. This nozzle was put by hand through the various openings in the side of the setting and by means of the steam jet the soot was blown off the tubes once every 12 hr.

The mechanical blowing apparatus used in these tests consisted essentially of 3 steam pipes, protected by several layers of insulating material, which were permanently located and passed through the setting in as many different places. Each pipe contained a number of small holes located in various places around its circumference, and connected to the atmosphere by means of small tubes or nozzles extending through the various layers of insulating material, as shown in Fig. 2. With this apparatus, the boiler tubes were cleaned at 3-hr. intervals. Between 1 and 2 min. were required to operate each pipe or blower of the mechanical cleaner, while by the former method about 20 min. were required, so that saving of time and labor resulted. With the use of the mechanical cleaner no doors are opened, therefore, the possibility of rapid expansions and contractions of the boiler is eliminated.

The series of tests reported cover sufficiently long periods of time to secure good, average operating conditions. All readings were taken every 15 min., on carefully calibrated instruments.

THE TESTS

COAL used was conveyed from the coal-pile by means of trucks, and fed into the hoppers of the under-feed stokers by hand, the weight of each truck being taken both when full and empty. The ashes were removed by hand from the ash-pit and the method of weighing was the same as for the coal. Clearfield coal was used, of which the calorific value for these tests varied from 14,651 to 14,557 B.t.u. per lb. of dry coal, as determined by an Atwater oxygen calorimeter of the Mahler bomb type. The percentage of volatile matter varied from 17.9 to 21.8 per cent as shown by carefully conducted proximate analyses for the several tests.

Weight of feed water was obtained by running it alternately into large tanks just as it left the feed-water heater. These tanks were placed on beam scales and when one was filled the weight was recorded, and the

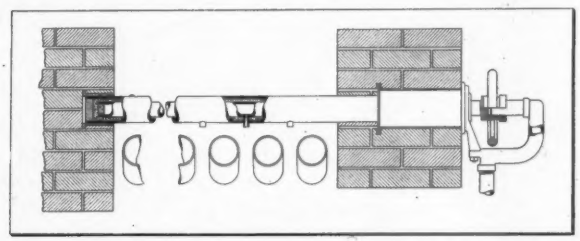


FIG. 2. CONSTRUCTION OF MECHANICAL BLOWER

water run out into the storage tank beneath it. During the time of filling one tank, the tare of another tank was being determined.

Temperatures of the flue-gases, which varied from 418 to 500 deg. F., were taken with a carefully calibrated pyrometer at a point in the horizontal flue above the boiler, at which point samples for gas analysis were also obtained. The carbon dioxide (CO_2) obtained from this analysis was checked by readings from a carbon dioxide recorder, the average value being 8.4 per cent by volume.

The plant carried its usual load, which consisted of one 300-hp. Ridgway engine, 2 Worthington feed pumps and one blower engine.

Tests consisted of "No. 1," of 8 hr. duration, and "No. 3," of 24 hr., during which the hand blower was used. Two other tests, "No. 2," of 12 hr., and "No. 4," of 24 hr., in which the mechanical tube cleaner was used, were run for comparison with the preceding, operating conditions being as nearly as possible the same for all 4 tests.

Comparison of Results

From a comparison of tests 1 and 2, the use of the mechanical blowers or cleaners shows a gain of 3.18 per cent, and 1.9 per cent for tests 3 and 4, making an average saving of 2.54 per cent. Figuring the average saving of coal on test 3, a saving of 2.54 per cent on a basis of a boiler efficiency of 64.8 per cent is equivalent to a profit of 3.93 per cent on a 100 per cent basis.

The weight of coal as fired was about 20,000 lb. a day and a saving of 3.93 per cent of this amount is 786 lb. a day, or 143.5 tons a year, which at $3 a ton would be $430.50 saved each year.

Comparison of Tests with Hand and Mechanical Tube Cleaners

	Test No. 1 with hand tube cleaner	Test No. 2 with mechanical tube cleaner	Test No. 3 with hand tube cleaner	Test No. 4 with mechanical tube cleaner
Duration of Test, hours	8	12	24	24
Water evaporated per pound of coal as fired, pounds	8.06	8.72	8.13	8.38
Equivalent evaporation at 212 deg. per pound of coal as fired, pounds	9.50	9.97	9.50	9.72
Equivalent evaporation from and at 212 deg. per pound of dry coal, pounds	9.61	10.06	9.72	9.93
Efficiency, including grates, per cent	68.3	71.5	64.8	66.7

The increase in equivalent evaporation between tests 1 and 2 is 0.47 lb. of water per pound of coal, and 0.22 lb. of water per pound of coal for tests 3 and 4, an increase in evaporation of 4.95 per cent based on results of tests 1 and 2, and of 2.31 per cent based on results of tests 3 and 4, or an average increase in pounds of water evaporated per pound of coal, of 3.63 per cent.

The movement to have goods made in this country marked as "Made in U. S. A." is gaining ground in nearly every line of industry, and seems to have behind it the argument of good sense and good business. If we are to send our products abroad, the phrase "Made in America" is not definite, because of the understanding of that phrase by people in other countries; particularly in South America the phrase would be of doubtful significance, while "Made in U. S. A." establishes definitely the origin of the goods, and should, if universally carried out, get to be as important as other designations of manufacture have been in years past. And as a matter of patriotism, since our own factories are our chief source of supply, and are fully entitled to our patronage, it would seem to be the part of loyalty for every citizen of the U. S. A. to favor, as far as possible, in his purchases, the goods having that mark. It should stand for the best that the world has seen in all manufactured products.

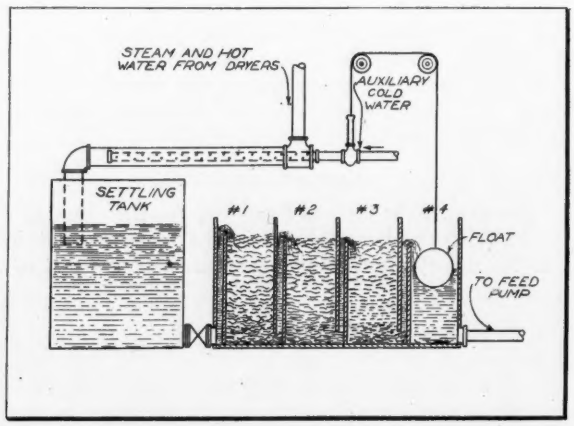
A vivid idea of what our disgraceful annual ash heap means to the nation is given by F. R. Morgaridge, Assistant State Fire Marshal of Illinois, who says: "Fire has cost this country more than it costs Germany to maintain its standing army. Our fire loss is equal to all our tariff duties; it exceeds the cost of our army and navy combined; it costs us more than our pension lists; the money we lose by fire would more than pay for the operation of our postal service. And the usual cause of fire is carelessness."

Purifying the Feed Water

By J. W. Grant

Due to the amount of oil and grease contained in the hot water and steam return of paper machine driers, employed in paper mills, the water cannot be used for boiler feed purposes until the oil and grease have been removed therefrom. The accompanying cut illustrates the design of a separator used in several eastern paper mills.

Steam and hot water returning from the driers are discharged into a large settling tank, which is connected by suitable nipples and valve to a 4-compartment filter. Upon entering a compartment the water must rise as shown in the figure and after reaching the top changes



SEPARATOR AND FILTER USED TO PURIFY FEED WATER

its course in a downward direction; but before reaching the bottom of the compartment it passes through a bed of meadow hay, which, acting as a filter, retains all of the greasy matter. This process is gone through 3 times, and by the time it reaches the fourth compartment it is in good condition to be used in the boiler.

The fourth compartment contains no filtering material, but has a float connected to a valve controlling the supply of auxiliary feed of cold water. When the supply of feed water is low, the float, being down, opens this valve, causing the inflow of the necessary amount of water, and after the water regains its normal level the valve closes, shutting off the auxiliary supply.

When the filtering material becomes saturated with grease, it is a simple and inexpensive matter to renew it.

In order to prevent corrosion, it is advisable to have all the piping connected with this system of brass.

Report is now ready by the United States Geological Survey and State Engineer of Irrigation of Oregon, on the possible development of the Deschutes River, tributary of the Columbia, which can be used in its head waters for irrigation of some 300,000 to 500,000 acres, the flow off from the irrigated area returning to the river lower down and being available for the development of some 600,000 hp. The details are given in Water Supply Paper 344, which can be obtained from the Director of the U. S. Geological Survey, Washington, D. C.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

The 2 New Electric Stations in Paris

REPLACING MANY SMALL STATIONS AND SIMPLIFYING DISTRIBUTION. BY FRANK C. PERKINS

POWERFUL steam turbines in the Paris electric plants and steam boiler and auxiliary equipment, as well as the new electric generating apparatus of the 2 central stations of the Compagnie Parisienne de Distribution d'Electricite, are of special interest on account of the varied service in that great metropolis of France, with its 3 zones of electric distribution. Until recently, for more than 2 decades since 1889, the City of Paris has been supplied with electric lighting and power service from half a dozen central stations distributing 3-wire and 5-wire direct-current service as well as alternating current to 6 different zones.

The Compagnie Parisienne de l'Air Comprime supplied the 5-wire continuous-current service at 440 v., and the Compagnie Continentale Edison operated a 3-wire direct-current system at 220 v. pressure, while the Societe d'Eclairage et de Force par l'Electricite supplied a 2-wire, 110-v. lighting service.

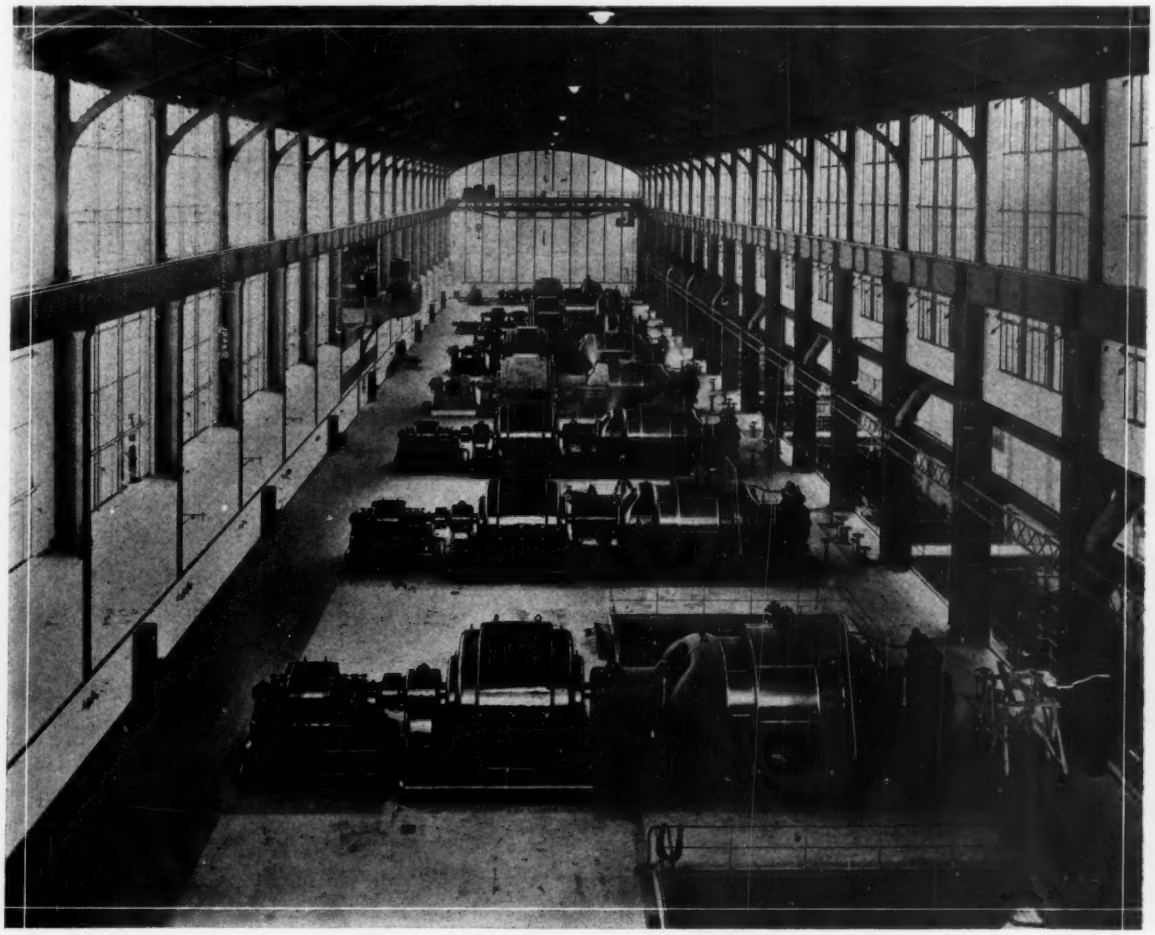


FIG. 1. TURBINE ROOM IN NORTH STATION

In the Champs Elysees section and the Rive Gauche, a single-phase alternating, 3000-v. distribution was utilized with transforming substations and central stations at Levallois, Issy-les-Moulineaux, St.-Denis and St.-Ouen. In 1907, plans were formed for combining the electric plants of the 6 zones into 2 great central stations, and in 1913, the Cie. Parisienne de Distribution d'Electricite was formed, this company absorbing all of the electric companies, and by this consolidation, the City of Paris was divided into 3 electric zones.

The New Plan

All of the continuous current, 2-wire, 3-wire and 5-wire systems of distribution were combined, forming a direct-current zone and the one and 2-phase zones were designed to include those sections of the City of Paris, supplied with the alternating current of single-phase and 2-phase systems. These 3 zones are supplied through substations with a 2-phase alternating current of 12,300 v. at a frequency of 42 periods per second from the Nord Central Station and the Sud-Ouest Central Station, the direct current being transformed at the substations

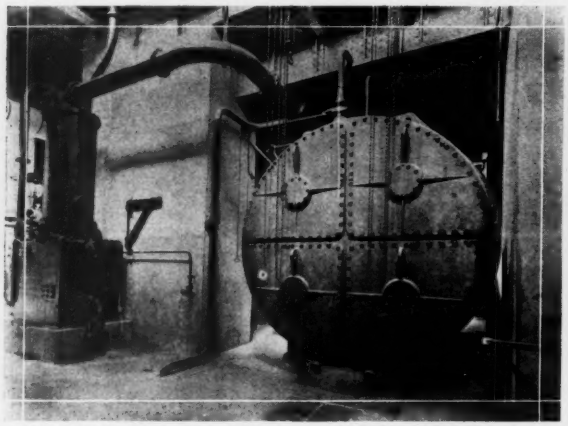


FIG. 2. CONDENSER AND OIL COOLER, SOUTHWEST STATION

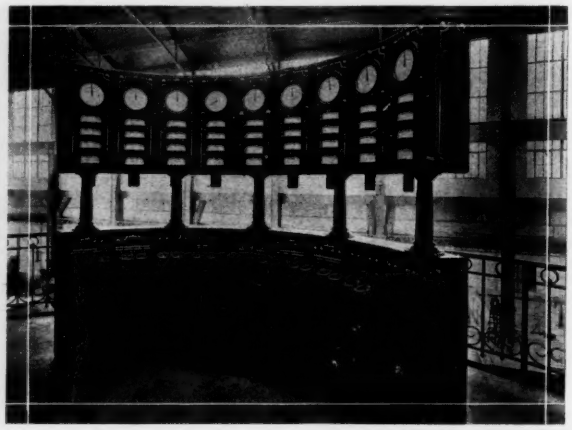


FIG. 3. BENCH CONTROL BOARD, NORTH STATION

connected by transmission underground cable lines with these 2 main central stations, the electrical steam turbine and boiler equipment of which may be noted in the accompanying illustrations.

The direct-current zone is in the central part of the City of Paris, while the single-phase zone is in the eastern section and the 2-phase zone in the northeastern portion of the city. In 1907, the distribution system of Paris included 345.5 miles of circuits, and 1913 the conductors had increased to over 710 miles in length.

In the continuous current zone there are 12 substations in which the 2-phase alternating current is transformed to a direct current for distribution on the 5-wire system at 440 v. and on the 3-wire system at 220 v. Motor generator sets are in use of 750 kw. and 1500 kw. capacity, supplying direct current to the 5-wire and 3-wire feeders and to storage battery plants, which are used for regulation.

These 12 substations in the direct-current zone have a total capacity of 67,000 kw. at present, with provision made for increasing the output to 97,000 kw. The single-phase zone on the river Seine has 4 substations which receive the 2-phase current from the Central Station at 12,300 v. and lower its pressure to 3000 v. for local distribution. The step-down transformers have a capacity of 600, 1200 and 1500 kw., and are of the air-cooled type. The present capacity is 36,000 kv.a., although provision has been made for later taking care of a load of 43,000 kv.a. The 2-phase zone is equipped at the present for a capacity of about 18,000 kv.a., while the 3 zones are interconnected with 74 cables, having a total capacity of over 200,000 kw., with the 2 Central Stations, Nord and Sud-Ouest, the total length of these cables being about 279.6 miles and consisting of 4 conductors for each circuit of 0.155 sq. in. cross section.

Station Equipment

The Paris Sud-Ouest Central Station has a capacity at present of 25,000 kw., while the Paris Nord Central Station will take care of a load of 50,000 kw., the ultimate capacity of these 2 central stations to be over 200,000 kw. In 1900, the electric station capacity in Paris was 22,000 kw., the total yearly consumption being 30,000,000 kw.-hr. In 1907, the load had increased to 39,000 kw., and the consumption for that year was 47,000,000 kw.-hr., while the total consumption for 1913 increased to 87,000,000 kw.-hr., with maximum load of 66,000 kw.

Underground cables and conduits have been provided of a total capacity of more than 200,000 kw., of which 150,000 kw. is for the St.-Ouen and 50,000 kw. for the Issy-les-Moulineaux systems. Each power house is 105 ft. wide, the north station having a length of 492 ft., while the south station has a length of 220 ft. and half the capacity, or 25,000 kw. The steam generators used in these stations are of 2 types, both of French construction, and include Babcock & Wilcox boilers of 4520 sq. ft. each, with a water volume of 424 cu. ft. and a steam volume of 191 cu. ft., also boilers of 3450 sq. ft. heating surface and a capacity for 120 cu. ft. of water and 152 cu. ft. of steam. There are 30 Babcock & Wilcox boilers and 10 Belleville boilers in the North Station, and 10 Babcock & Wilcox and 10 Belleville boilers in the South Station.

The Babcock & Wilcox boilers have superheaters of 1217 sq. ft. heating surface, while the heating surface of the superheaters of the Belleville boilers is 1992 sq. ft. Green economizers are used, each having a surface of

2580 sq. ft. The generators produce from 22,000 to 31,000 lb. of steam an hour at an effective pressure of 200 lb., and a superheat of 612 to 660 deg. F. The chimneys are each 16.5 ft. in diameter and 197 ft. in height. The stations are equipped with electric motor driven multistage centrifugal pumps of the Weyher and Richmond type, having a capacity of from 320 to 350 cu. ft., 4 being installed at the North Station and 3 of these electric pumps at the South Station. There are also in service several such pumps operated by steam turbines of the Brown Boveri Parsons type.

In the Paris North Station, there are 5 steam turbo-alternators of the Brown Boveri Parsons type and 3 steam turbines built by the Cie. Electro-Mecanique direct connected to 3 alternators built by the Ateliers de Constructions Electriques du Nord & De l'Est, also 2 steam turbo-alternators of the Fives-Lille design.

sq. ft. and a circulating pump operated by a Rateau steam turbine. There are also 2 electric pumps provided with 2 motors of 220 v. developing 270 hp. and 170 hp. respectively.

It is stated that these electric light and power systems for the 3 zones in Paris cost the Cie. Parisienne de Distribution d'Electricite more than $40,000,000, $9,000,000 being expended in building these 2 new central stations, which are considered by many engineers as the most up-to-date electric plants in Europe.

IN THE COURSE of its campaign for the safety of its employes, the Goodyear Tire & Rubber Co., of Akron, Ohio, which employs some 7500 men, has reduced serious accidents in its plant by 33 per cent, and minor injuries have decreased in the same proportion. Many safeguards have been installed by the safety engineer, such

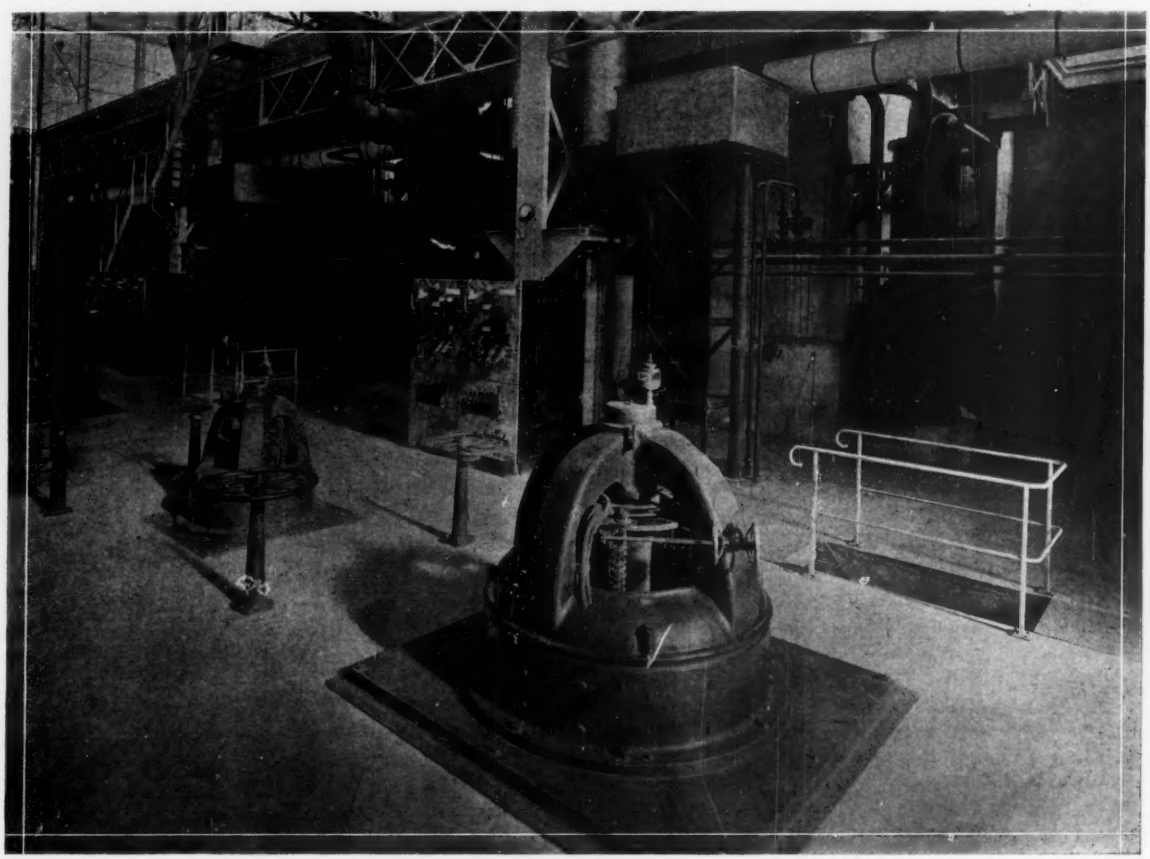


FIG. 4. CONDENSER PUMPS AND CONTROL BOARDS

In addition to the above, there are 2 steam turbo-alternators of the Zoelly-Ste.-Alsacienne design and one steam turbine of the Systeme Rateau direct-connected to a Fives-Lille alternator. In the South Station, there are 3 Zoelly-Schneider turbo-alternators operating at a speed of 1255 r.p.m., with a normal capacity of 10,000 kw., while for 2 hr. the capacity is 12,500 kw., and for half an hour a maximum output of 15,000 kw. Each turbo-alternator has its own exciter coupled to the same shaft, while there are also extra steam turbine-driven exciters provided. Each unit has a condenser of 21,500

as equipping elevator gates with screens to prevent articles falling down shafts, treating slippery floors, laying rubber mats wherever helpful, supplying rubber heels in many departments to guard against slipping, replacing old style ladders with new ladders equipped with safety shoes, furnishing goggles to men engaged in chipping and grinding, and other safeguards wherever found desirable. In addition, safety rules are adopted for each department, and those employed in that department are required to become familiar with them.

Practical Electrical Engineering

Synchronizing

IT IS EVIDENT that a voltmeter will not indicate when 2 alternating-current electromotive forces have a coincidence of waves unless connected in some other than the usual way. The simplest way of indicating phase relations is by the use of lamps; these are nearly always used at the present time, though generally in conjunction with other apparatus. Assuming the alternator electromotive force to be 110 v., for the sake of example,

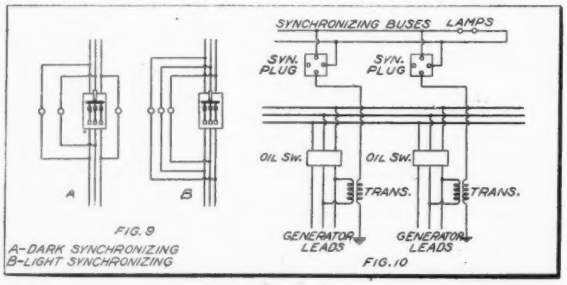


FIG. 9. WIRING DIAGRAM FOR SYNCHRONIZING LAMPS
FIG. 10. SYNCHRONIZING LAMPS IN ONE PHASE OF A 3-PHASE SYSTEM

the lamps would be connected as shown in Fig. 9 at A. If the buses and switch points on the generator are of the same polarity and potential the lamps will remain dark; at unequal voltages they will glow with a brilliancy dependent upon the potential difference. If the polarity is opposite, there will be a total of 220 v. across the 2 lamps in series and each lamp will burn at normal candlepower. In other words, when the lamps are dark the switch can be closed.

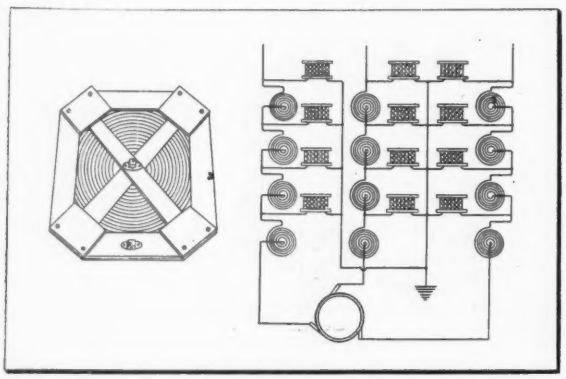


FIG. 12. CONNECTIONS OF LIGHTNING ARRESTERS ON 200-V. SYSTEM

To synchronize light, the connections should be arranged as shown at B in Fig. 9. Now as the lamps are connected between points of opposite polarity it will be seen that the switch should be closed when the lamps are at their greatest brilliancy. If the waves coincide perfectly at all points, the lamps will remain either light or dark, depending upon the method used. If the waves do not coincide owing to difference in frequencies, the lamps will flicker, becoming alternately light and dark as the potential across the lamps is varied with the wave relations.

Up to 440 v. potential, synchronizing lamps are connected in series; but for higher voltages, too many lamps would be required, so transformers are used in conjunction with them. This does not complicate the apparatus, for the leads should be considered as merely coming through the transformers, in no way affecting the preceding explanations. The primary and the secondary

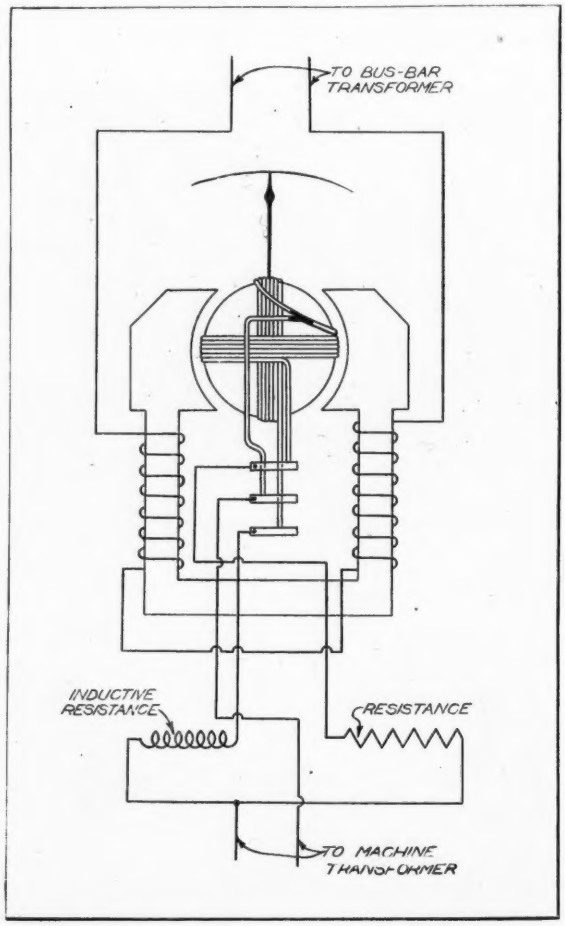


FIG. 11. DIAGRAM OF CONNECTIONS OF SYNCHROSCOPE

electromotive forces reverse at the same time, so that when the secondaries are in step the primaries must also be in step. Figure 10 shows a diagram with lamps in one phase of a 3-phase system and using synchronizing plugs for convenience in connecting.

Synchroscopes and Automatic Synchronizers

SYNCHRONIZING indicators or synchroscopes used to determine the phase relation between incoming machines and those already in operation, consist in principle of a miniature revolving field induction motor

having a pointer attached to its rotor. The revolving field of this motor is due to any time phase between the electromotive forces of 2 alternators; and the instrument pointer rotates to the right or to the left at a speed equal to the difference of the frequencies of the 2 voltages. When synchronism is reached, the pointer comes to rest on zero and the alternator switch may be closed. The connections of one type of synchroscope are shown in Fig. 11.

Although the synchroscope is a most desirable device, it does not perform the actual work of closing the alternating-current switch, but merely indicates when the conditions for closing the switch have been reached. In order to eliminate the danger which exists when switches are operated manually, use is made of an automatic

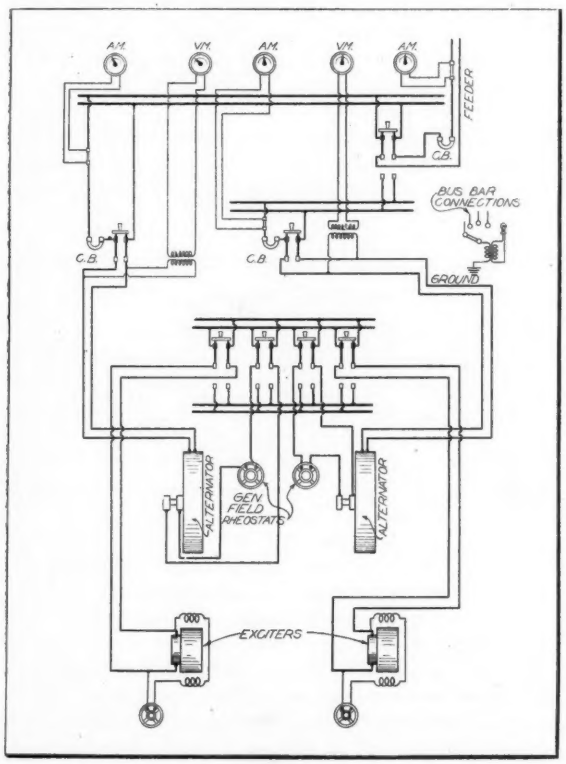


FIG. 13. WIRING DIAGRAM OF 2 SINGLE-PHASE ALTERNATORS

synchronizer which closes the switch when the speed of the incoming machine and its electromotive force are in time phase with the system supply.

An automatic synchronizer may be constructed of 2 solenoids acting oppositely upon a relay switch lever, the rapid movement of which is retarded by a dashpot. One of the solenoids should be connected to tend to close the switch when the electromotive force of the incoming machine is directly out of phase and the other should tend to open the switch when the electromotive force is directly in phase with that of the supply system.

When the speed is either too fast or too slow, the solenoids tend alternately to close the switch, the dashpot preventing the switch from being closed completely. When the speed is correct and the electromotive force of the incoming machine remains in time phase with the supply electromotive force for a sufficient length of time, the dashpot allows the proper solenoid to close the switch when the phase relation is correct.

Lightning Protection

Principles of lightning arrester construction and operation for direct-current work apply, with but few modifications to alternating-current work. Many types for the latter service are made up of several small cylinders of so-called non-arcing metal separated by minute air spaces, so that the discharge has to pass over several gaps tending to prevent the line current from following.

Reactances are made greater and in the form of coils, known as choke coils; several arresters with their choke coils are connected in series for the high voltages. Figure 12 shows the connections of arresters for a 200-v. system.

Switchboard Connections

What has been said regarding conductors for direct-current switchboards will apply to alternating-current boards with the exception that conductors of ½ in.

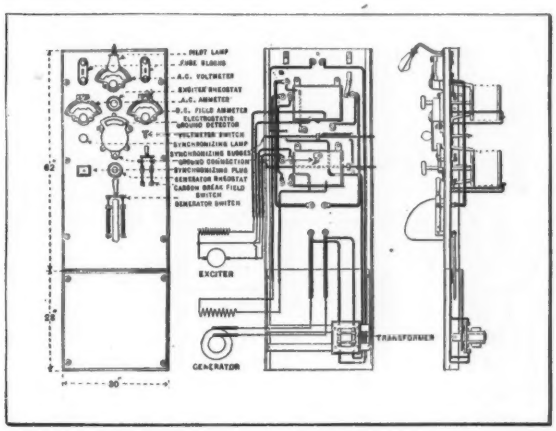


FIG. 14. THREE VIEWS OF A SINGLE-PHASE 2300-V. GENERATOR PANEL

and over in diameter should be stranded, as beyond this size there is considerable more drop in potential than that due to ohmic resistance. This is owing to the so-called skin effect, a property possessed by alternating currents tending to distribute themselves unequally across the section of a conductor, flowing more on the surface than the interior. This effect depends largely upon the frequency, decreasing with a decrease in frequency.

Taking up the subject of connections, where there are several generators in a plant it is more economical to use one exciter of sufficient capacity for all of the machines than to have a separate exciter for each providing an extra exciter is held in reserve for emergency purposes. It is customary to have one exciter driven by a steam engine or turbine, which is used when starting up after a shutdown and for emergency purposes, and an exciter for regular duty driven by an induction motor.

Connection diagram of 2 single-phase alternators, Fig. 13, shows how either one of 2 exciters may be used. Each one is connected to a double-pole double-throw switch at the center and the switch contacts on both

ends are connected to auxiliary busbars. The generator fields are also connected to double-throw switches in a similar manner, so that either exciter can furnish current to the fields of both machines or each alternator may receive field current from an independent exciter.

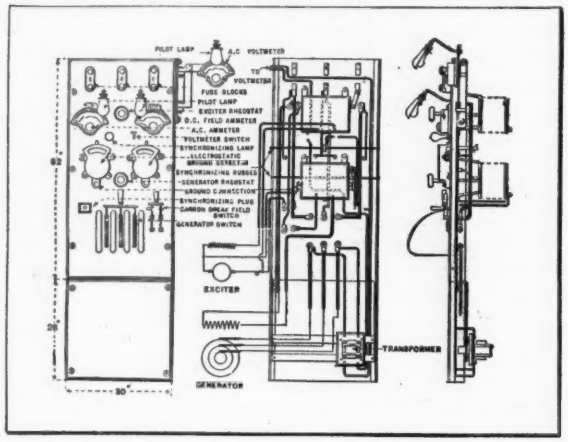


FIG. 15. THREE VIEWS OF A 3-PHASE 2300-V. GENERATOR PANEL

In this particular diagram the 2 alternators are connected in such a manner that they operate independently and double-throw feeder switches enable any portion of the load to be thrown on either machine. This arrangement is applicable to small plants for lighting loads.

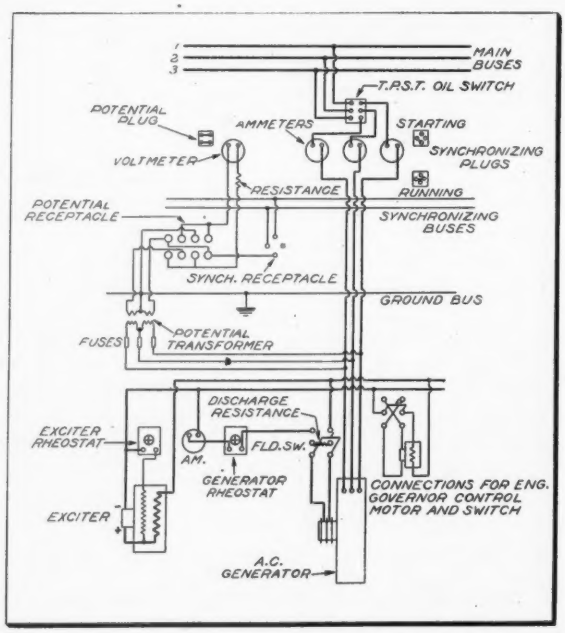


FIG. 16. DIAGRAM OF CONNECTIONS OF A 3-PHASE GENERATOR PANEL

Single-phase alternators are rapidly going out of use and where a single-phase system is used it is generally supplied by one phase of a 3-phase machine. The arrangement of the exciters can be used equally well with polyphase alternators.

Figure 14 shows 3 views of a single-phase 2300-v. generator panel; a 3-phase 2300-v. generator panel is shown in Fig. 15, while Fig. 16 illustrates the connections of a 3-phase generator panel.

An Electricity Thief

METHODS EMPLOYED IN STEALING CURRENT

CENTRAL stations are as subject to the pilferings of dishonest persons as is the merchant or the common citizen. A few years ago the writer was instrumental in bringing about the arrest and conviction of one of these wire tappers, whose workings were quite interesting.

As foreman in charge of the meter department, the writer was brought into contact with the installation of every electric light and power customer. One of these was a young man, a wireman in the employ of a local electrical contractor, who had, as might be expected, wired his own home for light and, as was afterward discovered, for power also. The job had been inspected and found O. K. by the city electrical department, and as a result the customer had always been considered of good standing.

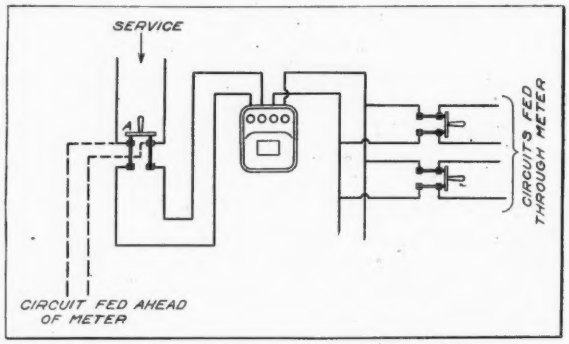


FIG. 1. CIRCUIT CONNECTED AHEAD OF METER

The public service laws of the State in which this incident occurred require the testing of all small service meters once a year, a fact with which this wireman was acquainted, and had it not been for an error on the part of the meter tester who called before the year's time had expired, the offender would undoubtedly still be getting free current.

Having made a test on the meter and completed the necessary adjustment so as to make the instrument correct at all loads, the meter tester closed and sealed the meter. Before leaving, however, as was his habit, he turned on a few of the house lights to observe the performance of the meter under its own load. To his surprise, he discovered that the meter responded only to about ½ of the lights. After careful observation and inspection of all visible wiring, the man came to the conclusion that, whatever the cause of this peculiar state of affairs may have been, it must be in the concealed section of the wiring. As shown in Fig. 1, the meter, switches and main fuses were mounted on a square board, and upon unscrewing the main switch, A, he found that an independent circuit had been connected thereto by being soldered to the bottom of the switch

terminals, resulting in the greater part of the load being connected to the service ahead of the meter.

The discovery was not reported to the lighting company's officials, but the wireman was notified of the find and instructed to change the connections or suffer the consequences. After expressing his regret for having made such a connection he returned home, and within a few days had connected all his load on the proper side of meter as Fig. 2 illustrates.

Instead of waiting a year to test this meter again, the writer called at this installation a few months after for the express purpose of satisfying himself that everything was now as it should be.

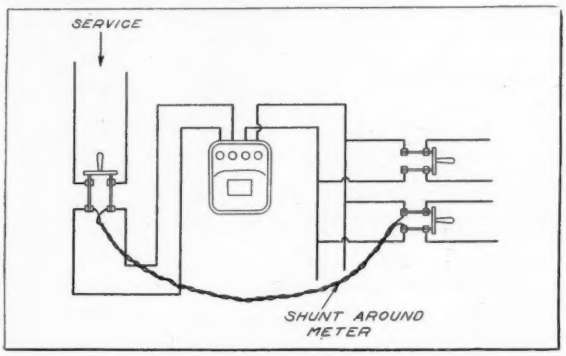


FIG. 2. JUMPER SHUNTING METER

Imagine his surprise when he found, even though all the wiring proper was O. K., that this man had resorted to a newer but more clever scheme. Having in addition to the main switch, 2 circuit switches on the load side of the meter, he provided himself with a short length of lamp cord, the ends of which were well soldered and bent over to form hooks which he could readily connect from the blades of the main switch to those of either one of the other circuit switches, thereby forming a heavy shunt around the meter. This being easily connected and disconnected, he could remove it at any time he expected a visit from an inspector or meter reader. He was now, however, caught unawares, and with the goods on him.

The matter was brought to the attention of the company's officials, who at once caused his arrest. A heavy fine, costs and the payment of the estimated amount of current stolen was his punishment.

WORK IS BEING CARRIED FORWARD rapidly on the Monroe Bridge plant of the New England Power Co., which is located above Shelburne Falls, Mass., on the Deerfield River, and was referred to in the articles descriptive of that company's development in the issues of December, 1913.

Work was started last May and has been pushed rapidly so that the conduits and canal are now nearly completed. Water is carried a long distance by means, first, of a conduit leading out from the dam into a tunnel, and from this into a canal 6500 ft. in length, from which it enters tunnel No. 2, with a conduit and a second canal 1150 ft. in length, and beyond this a third canal 3000 ft. in length, at the lower end of which is a third conduit terminating in a surge tank and delivering water to the power house under a head of 235 ft.

Sand in Main Bearings

BY T. H. DE SAUSSURE

SOME time ago there was quite a discussion among the boys on the practice of using sand as a means of cooling a hot bearing; and it was amusing to hear the diversity of views on the subject.

The crux of the thing is, what is to be considered as "sand"; and the fact that the material of which the bearing is composed must be considered in connection with the quality of the sand used. We have often ground down troublesome line shaft bearings with powdered pumice stone, which in this connection, may be considered as a fine sand.

As an example of sand in the wrong place, the following experience is a good one.

I once set up a high-speed automatic engine of a well known and good make, the main bearing of which began to heat soon after it was put to running. This bearing consisted of a bottom box, 2 side boxes operated by wedge bolts and a cap. Each of these parts was a cast-iron shell filled with babbit metal and neatly scraped to a bearing. Soon after starting the engine, this main bearing began to heat and notwithstanding the application of all the well known remedies for hot bearing, it got hotter and hotter till the engine had to be shut down. On taking off the cap, the journal was found to be pretty badly scored and the babbit in bad shape. The journal was drawfiled and polished and the babbit in all the parts of the box scraped to a good fit. Another start was made, the engine being run at slow speed for a while. As soon, however, as the speed was up to normal the trouble began again and the bearing got so hot that the engine had to be shut down. In taking off the main bearing cap, the journal was found to be scored and cut as badly as at first. It was decided to cut the babbit out of the cast-iron shells and put in new metal.

When the babbit was ripped out, the mystery of the heating of that bearing was a mystery no longer, for there was the trouble in full view: The molding sand had not been properly cleaned from those castings before the babbit was poured, and the loose sand being lighter than the metal, some of it had risen to the top, making about as unsatisfactory a bearing as can well be imagined. Two heaping tablespoonfuls of sand were taken out of those castings. After new babbit was poured and fitted as before, that main bearing has been a joy—has never been warm in 6 yr.

Another instance of sand in the wrong place: One Saturday afternoon, an oiler undertook to polish the top surface of the cap of the main bearing of an old engine which had lots of bright work on it. He took out the oil cup from the top of the cap and with a sheet of sandpaper on a block of wood went to work on that cap without first stopping up the oil hole with a rag. He made a fine job of the polishing, but that main bearing ran unduly warm for several weeks. He must have got a quantity of sand down the oil hole.

THE MALONE, N. Y., LIGHT & POWER CO. is completing construction work of 18 months duration, and involving an expenditure of over $400,000.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Producer Gas from Low Grade Fuels

SHORTAGE OF COAL FORCES USE OF LOW GRADE FUELS; COMPARISON OF OPERATING COSTS; DETAILS OF PRODUCERS. BY R. H. FERNALD

DUE TO THE great consumption of coal in this country, it is estimated from reports of the U. S. Geological Survey that, if the rate of increase of fuel consumption that has held for the past 50 yr. is maintained, the supply of easily available coal will be exhausted before the middle of the next century. As a matter of fact, the fuel consumption per capita is actually increasing much faster than the population, so that the question of the continuation of this rate of increase is one of considerable importance.

In view of the necessity of utilizing for the production of power, grades and varieties of fuels which until recently have been considered uneconomical, the U. S. Bureau of Mines has conducted a number of investigations on the making of producer gas from such fuels.

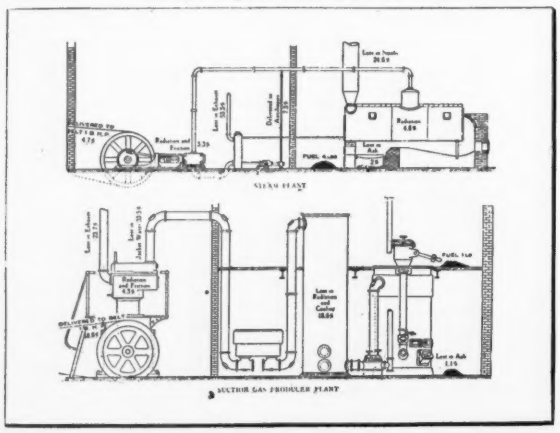


FIG. 1. DISTRIBUTION OF HEAT IN STEAM AND GAS PLANTS

Introduction of the gas producer into this country for power plant work was made about the year 1900. While the number of installations in that year was no more than 4, in 1911 it was estimated that this figure had increased to from 650 to 700 and of these a large proportion were double installations, which were not counted separately. To-day, the number of gas producer power plants in this country is in the neighborhood of 1000. Total increase in horsepower of these plants has been from 2000 in 1900 to 170,000 hp. in 1911, some 85,000 of which was obtained from bituminous coal, 75,000 from anthracite and about 10,000 from lignite.

Figure 1 well illustrates the distribution of heat in typical steam and gas power plants. The heat losses in the 2 plants are as follows:

HEAT LOSSES

Steam Plant

	Per Cent.	
In ashes	2.00	
In radiation and cooling	4.60	
In smoke	24.60	
Total boiler losses	31.20	
In radiation and friction	3.30	
In exhaust	53.50	
In jacket water		
In auxiliaries	7.30	
Total losses in entire plant		95.30
Net efficiency of plant		4.70

Gas Plant

	Per Cent.	
In ashes	1.10	
In radiation and cooling	18.60	
In smoke		
Total producer losses	19.70	
In radiation and friction	4.30	
In exhaust	23.70	
In jacket water	33.50	
In auxiliaries		
Total heat losses in entire plant		81.20
Net efficiency of plant		18.80

Original heat of coal in both plants = 13,500 B.t.u. per lb.

It is evident from the above figures that as far as net efficiency of the plant is concerned the gas plant is far ahead of the steam plant.

TYPES OF PRODUCERS

SEVERAL types of gas producers are now in use, among them the suction type, the up-draft pressure type, the down-draft type and the double zone type.

Figure 2 illustrates a suction producer in its simplest form, the operation being as follows: Producer B is fed with fuel from the hopper, F, which is provided with some feeding device so that the fuel may be dropped into the container below without admitting air. C is for vaporizing the water and mixing it with the air, the steam saturated air passing down through pipe P to the bottom of the producer. Hot gas leaving the

producer enters a vertical pipe, E, the upper part of which can be opened to the air to allow the poorer gases to escape when starting, draft being furnished by the starting fan, D.

Gas passes down the vertical pipe through a water seal to the coke scrubber, G, tar collecting at the bottom of E and running into the tank shown. From the

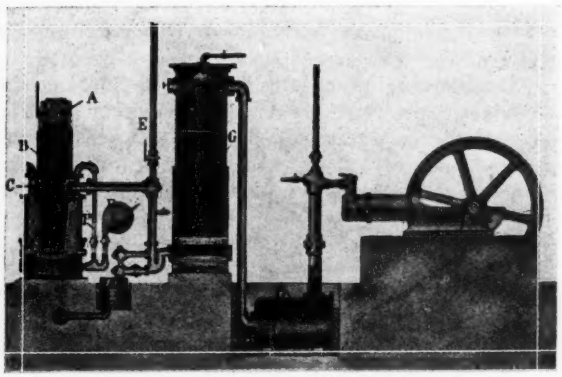


FIG. 2. SECTION OF SUCTION GAS PRODUCER

scrubber the gas passes into the expansion box, H, whence it is drawn by the piston of the engine into the cylinder.

Gas produced by the use of air and carbon only has certain excellent qualities for power purposes, but is rather low in heat value, and in making such gas there is a tendency for the temperature to rise to such a point that excessive clinkering is produced and fuel troubles are caused. Introduction of water or steam keeps the temperature at a sufficiently low point to prevent clinker formation.

Removal of Tar

Getting rid of the tar, after it is removed by some form of tar extractor, is a serious problem, and many attempts are being made to effect an increased utilization of this product commercially.

Figure 3 shows a system in which arrangement is made for converting the tar into gas available for use in the engine. The method is to run 2 generators on a certain grade of fuel. The bed is a layer of coke; on top of which the fire is built, and green coal is charged in over the fire, by which means an incandescent bed is formed. Draft produced by the exhauster draws the gas from the green coal downward through the incandescent bed, and the tarry compounds are supposedly converted into gas. The products are then drawn through the wet and dry scrubbers to the holder. As shown in the figure, the exhauster is situated between the wet and dry scrubbers.

With the above system, after a certain period of operation, the tarry compounds, dust, soot, etc., tend to clog the fuel bed and increase the pull on the exhauster from a normal of 5 or 6 in. of water to as much as 20 in. It is then that the process of "shooting the bed" is gone through, which consists of closing the charging doors and gas valve and turning on under the grates, steam at a pressure of from 60 to 80 lb. per sq. in. This jet of steam shakes up the whole fuel bed and sends the dirt, dust, soot, etc., through the bypass into the other gas generator.

After the process is completed, the gas has a heat value of about 200 B.t.u. instead of 105 B.t.u.

A double purpose is served with this type of plant, as 2 kinds of gas are produced—the first being commonly called air gas and the second water gas.

If no water gas is required, the bed is shot just as seldom as possible, sometimes not oftener than every 6

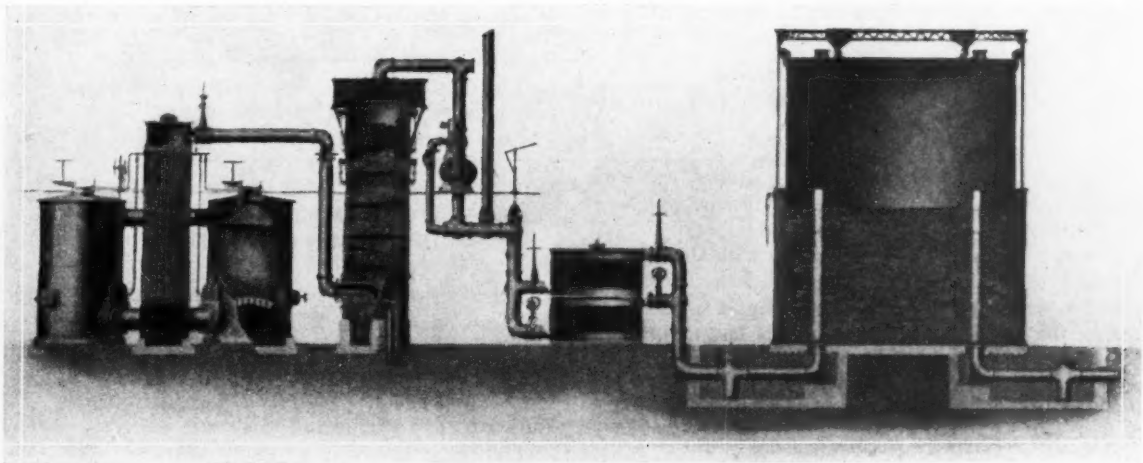


FIG. 3. ARRANGEMENT FOR CONVERTING TAR INTO GAS

When producer gas is made from coal, its constituents are carbon-monoxide, a limited percentage of hydrogen and a small amount of marsh gas, the carbon monoxide being the main constituent.

Some gas producers embody special features such as revolving grates and automatic feeds, and there is on the market a mechanically-poked producer.

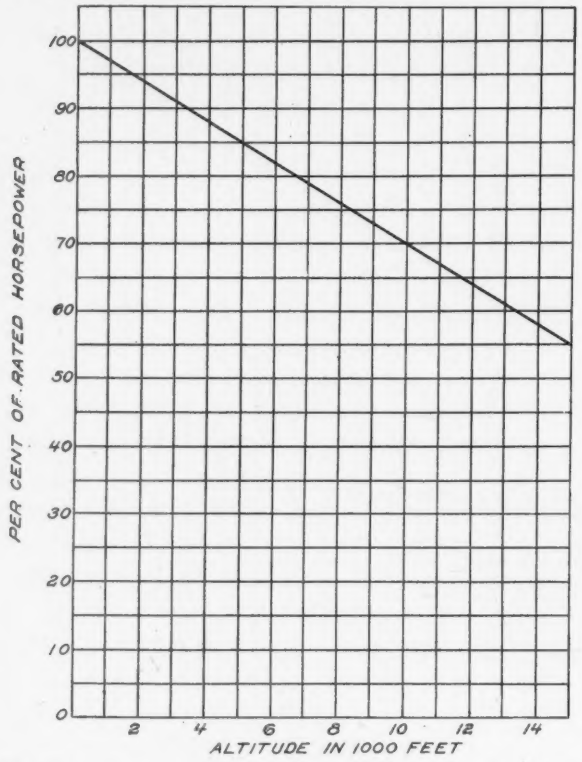
hr., while if water gas is desired for such purposes as heating, tempering, annealing, etc., the bed is shot as often as possible.—Journal of The Franklin Institute.

The U. S. Bureau of Mines reports that the daily waste of natural gas in Oklahoma alone is 70,000,000 cu. ft.

Gas Engine Horsepower

THE EFFECT OF ALTITUDE ON FUEL SUPPLY, COMPRESSION AND BACK PRESSURES

IT has been the writer's experience that many students, and in many cases men who have had considerable gas engine experience, have the idea that the power of a gas engine increases as the altitude increases. They figure that at the higher altitudes the engine exhausts against less back pressure, and therefore its power is increased.



RELATION OF ALTITUDE TO DEVELOPED HORSEPOWER OF GAS ENGINES

Although the engine is exhausting against less back pressure, it is this same atmospheric pressure that supplies the engine with its mixture of fuel and air. If the pressure that supplies the cylinder with the mixture is reduced, the compression is reduced because the actual amount of mixture forced into the cylinder is less. As a result, the mean effective pressure is less and, therefore, of course, the actual output is less.

The decrease of power is in direct proportion to the decrease in atmospheric pressure. So if the altitude is known the barometric pressure in inches of mercury or the pressure in pounds per square inch can be obtained. Then a simple calculation will give the horsepower at that altitude. As a formula, it is as follows:

$$H_2 = \frac{P_2}{P_1} H_1$$

Horsepower at given altitude = Horsepower at sea level, times ratio of atmospheric pressure at given altitude to atmospheric pressure at sea level (14.7 lb. or 29.9 in. of mercury.)

Approximately the atmospheric pressure decreases 0.5 lb. per 1000 ft. elevation. This is close enough to give a good idea what the engine will deliver at the required altitude. The following table gives the atmospheric pressure at various altitudes up to 2 mi.

Alt., mi.	0	¼	½	¾	1	1¼	1½	2
Atmos. Pres., lb.	14.7	14	13.3	12.7	12	11.4	10.9	9.8

A more rapid and convenient method of calculating the horsepower at various altitudes is by a power curve, such as the one shown. This power curve will give results that are very accurate.

The following problem will serve to illustrate the methods of determining the horsepower. Problem: Required the power a 250-hp. gas engine will develop at an altitude of 1½ mi. above sea level when using the same fuel as that which gives the engine the 250-hp. sea level rating.

At an elevation of 1½ mi. the atmospheric pressure is 10.9 lb. per sq. in. Now substituting in the formula:

$$\text{Power} = 250 \times (10.9 \div 14.7) = 185.3 \text{ hp.}$$

An altitude of 1½ mi. is practically 8000 ft. On the diagram, the power curve crosses the 8000 ft. altitude line at practically the 75 per cent horizontal line. So the engine at 8000 ft. should develop 75 per cent of its rated sea level power or $0.75 \times 250 = 187.5$ hp.

Luck

BY R. T. STROHM

HE was downright poor, and he couldn't pay
For the thing that the college calls B. A.
So he seized on the only other way
For the culture of his mind.
He purchased books, and he thought and read
Till he'd crammed their contents through his head,
And he cut out play and he shunned his bed
That he might have time to grind.

He fixed his eye on the distant goal
And he dug and delved like a human mole,
Till the very depths of his heart and soul
Were thrilled with a triumph song.
His aloofness won his companions' sneers
And drew their taunts and their caustic jeers,
But he closed his eyes and he stopped his ears
While he slowly forged along.

And then there dawned the momentous day
When a golden chance fell across his way
And he gripped it tight, with a grip to stay
Till it raised him from the ruck,
While the common herd, that had loved to shirk
The stress of thought and the strain of work,
Looked up at him with a jealous smirk
And swore at his wondrous luck!

PHOENIX CONSTRUCTION CO. has completed its plant at Waco, Texas, representing an investment of $800,000, the present plant being ¼ the installation when completed. A 7500-kw. unit is now ready for service, and 3 others are to be installed as the demand warrants. Current will be supplied in all directions from Waco within a radius of 100 miles.

Management of Evaporators

GETTING BEST EFFICIENCY AND KEEPING WATER PURE. BY STERLING H. BUNNELL

OF the various methods of softening and purifying water, evaporation is the one completely effective process. In evaporators, every kind of solid impurity is left behind by the water in changing to steam, and all gases in solution are driven off. The use of evaporators is, therefore, extending from marine to stationary service. For producing pure water for ice-making, for bottling purposes, and for chemical uses, evaporating apparatus already forms a part of many steam-power plants, so that every progressive engineer will do well to make himself familiar with the principles and practice of its operation.

The evaporator may be described as a steam boiler heated by steam, and constructed to allow of easy removal of the solids left behind by the water when vaporized. The evaporator therefore consists of a shell containing steam heating tubes. Steam admitted to the tubes condenses and gives up its heat to water surrounding the tubes, causing the water to boil and form steam. In the common marine evaporator universally used on ocean-going vessels, the steam pressure in the tubes is usually kept at 30 to 50 lb., while the vapor pressure in the shell is atmospheric, or less. The temperature of the steam under pressure is therefore higher than the boiling temperature of the water in the shell and so causes the water to boil rapidly. The vapor formed in the shell is piped to the main condenser for boiler feed make-up, or a part is diverted to a separate distilling condenser, by which pure water is obtained for supplying the ship's passengers and crew.

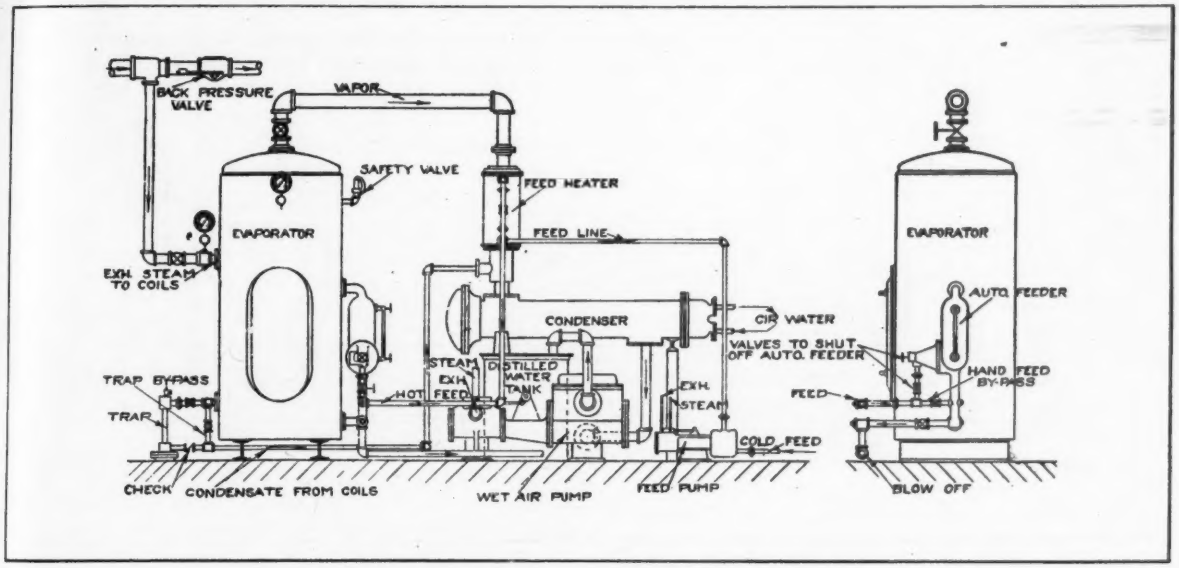


FIG. 1. TYPICAL SINGLE EFFECT EXHAUST STEAM ARRANGEMENT

CAPACITY

THE AMOUNT of water evaporated depends on the difference of pressures (and therefore of temperature) of the steam which does the heating, and the water which is being evaporated. If the steam pressure is raised, or the evaporating pressure is lowered, the output will increase corresponding to the increasing difference between the heating and evaporating temperatures. The output of such an evaporator can thus be varied as desired. With the pressure (and temperature) the same inside and outside the tubes, there would be no transfer of heat, and no water vaporized. As soon as the heating pressure is increased, to produce the necessary difference in temperature, the water will commence to give off vapor. The same result can be produced by diminishing the evaporating pressure, as by piping the vapor into a condenser, in which case evaporation will take place at a temperature below 212 deg.

MULTIPLE EFFECT

EVAPORATORS may accordingly be connected up in "multiple-effect" series, starting with high-pressure steam and ending with a condenser. The vapor in the first "effect" is produced at a temperature a few degrees below the temperature of the boiler steam which heats this effect, and this vapor passes into the heating tubes of the second effect. The vapor formed in the second effect passes into the heating tubes of the third, and so on to the last, the vapor from which passes into a condenser. The heating tubes of each effect are drained of the condensed steam by traps. All the condensate is pure water, and is collected together with water from the condenser.

In each effect, the quantity of steam condensed in the heating tubes evaporates nearly as great a quantity of water (0.8 to 0.9 is the usual ratio in the shell). Taking the lower figure, 2 effects therefore produce from

1 lb. of steam, $1 + 0.8 + (0.8 \times 0.8) = 2.44$ lb. of water; 3 effects produce $0.8 \times 0.8 \times 0.8 = 0.512$ in addition, or nearly 3 lb. in all, and so on. The only limit to the number of effects which can be used is the practical one, that with a great number of effects the temperature differences become so small that the evaporators turn out very little water per square foot of heating surface, and so the plant becomes too large and expensive.

With a boiler pressure of 125 lb., corresponding to a temperature of 353 deg., and a vacuum of 26 in., corresponding to 125 deg., the total range of temperature is 228 deg. Four effects with this range would have a difference of 57 deg. per effect. Eight effects would have only half this difference, and would therefore turn out about half the water per effect, or the same total quantity, while the 8 evaporators would cost twice as much as the 4. But the 8-effect plant would take little more than half as much boiler steam, and need less than half as much surface in its condenser, as compared with the 4 effects.

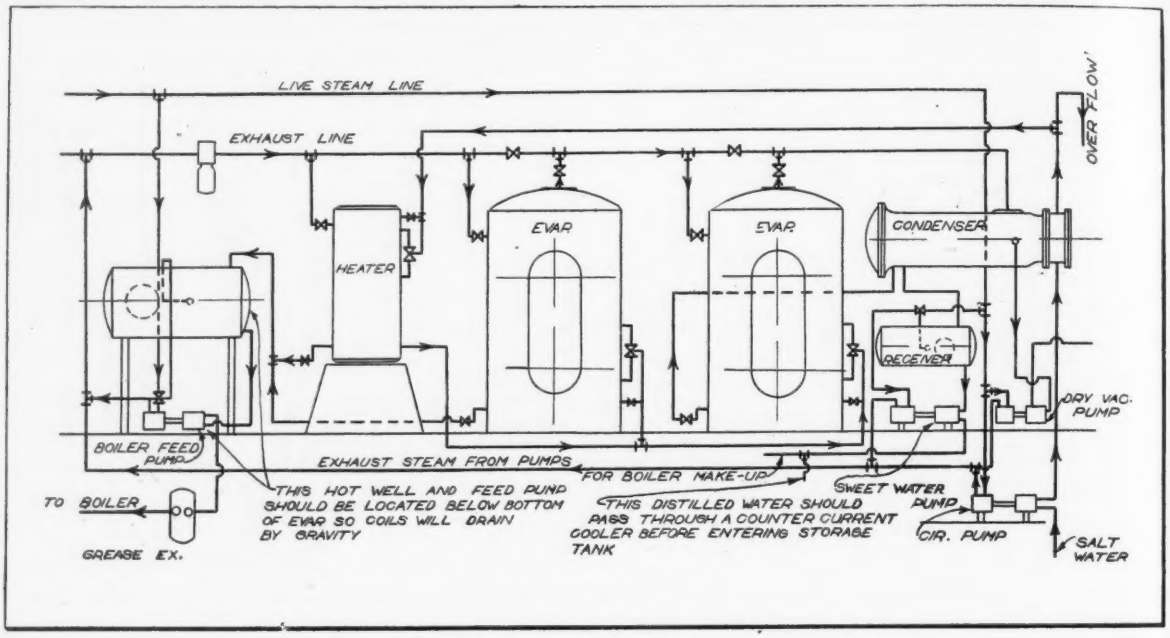


FIG. 2. DOUBLE EFFECT EXHAUST STEAM EVAPORATING PLANT

If, instead of live steam from a boiler, exhaust steam from an engine or ice machine is to be used for heating the evaporators, the proper number of effects depends on the amount of exhaust steam available, and the amount of water wanted. In some cases, it is desirable to proportion the evaporators so as to condense all of the exhaust, and waste any surplus of evaporated water.

The operating of evaporating plants requires little labor, and usually no great amount of continuous attention. A good working familiarity with the action of water and steam under varying pressures is necessary. The evaporating plant reaches all the way from the boiler to the condenser, and may include traps, pumps, gages, feed water regulators, and in ice plants, reboilers and filters. With everything in working order, the plant may run on for hours or days together without a touch, the action is so automatic.

Starting a Plant.

In starting an evaporating plant, the first thing is to have everything clean, and particularly so if the water is to be used for ice-making or other purposes demanding perfect purity. The interior of the shells, and the tube surface, should be inspected, any scale deposits from previous use should be removed, and the interior of the shells should be washed out thoroughly with clean water. The access doors should be closed up and made tight. The shells should then be filled with water to the middle of the water gages or to the proper level if any is specially indicated by the maker of the apparatus. The drain lines from the heating tubes, which are usually provided with steam traps, should then be opened up ready to clear the tubes of condensed water.

The steam may now be turned on to the evaporator—the first or high pressure one, if the plant has several "effects." This evaporator will gradually heat up until vapor is formed and pressure begins to show on the steam gage connected to its shell. If the heating apparatus appears to be too slow, it is probable that the heating coils are blocked by air or water, and the drain line should be tested, its air vent opened wide, and the condensed water permitted to flow from the tubes until it comes away nearly as hot as the steam supply to the tubes. It is absolutely necessary that evaporator heating coils shall drain freely and keep clear of air, in order that steam may enter them, condense freely therein, and so give up its heat to the water.

When the pressure in the shell of the first effect reaches about ½ the pressure of the steam in the tubes, the vapor valve admitting steam from the shell of the first effect to the heating tubes of the second effect may be opened, and the second effect in turn heated up. The same care must be taken to see that air and water are freely drained from the heating coils of this effect, in order that the vapor may enter them and condense therein. The water in the shell will then heat, and eventually

show pressure on the gage. As the shell pressure of No. 2 approaches the shell pressure of No. 1, the vapor valve of No. 2 may be opened, and steam admitted to No. 3. In the same way, the entire plant will be brought into operation.

All the water drained from the heating tubes of the various effects passes through the traps to the pure water tank. As the various traps discharge water at different temperatures, some of them above 212 deg., some of the water will flash into steam when relieved of pressure, unless discharged under the surface of the pure water in the tank. If the various tubes discharge into a common line, this should be of ample size, to prevent back pressure on any of the traps.

Evaporating plants working below atmospheric pressure must include condensers to receive the discharged water from the effects working below atmosphere, and the vapor from the last effect of the series; and air pumps to drain the condensers against the atmospheric pressure. The condensing apparatus is to be started as soon as vapor is admitted to the first shell intended to work under vacuum. As compared with condensing apparatus for steam engines, evaporator condensers in multiple effect plants receive much water, little steam, and a very large amount of air coming from the raw water heated in all the effects. The pump connections should therefore be arranged to allow large quantities of air to escape freely, and to keep the air-pump water-sealed, even though little water may come through it at occasional periods.

Restarting

Ordinarily, in starting an evaporating plant which has been in recent and regular use, it is unnecessary to touch the valves of the various effects, but simply to treat the whole plant as a unit, admit steam to the first effect, and start the air pump if the plant has one. The pressures will pick up and gradually adjust themselves at the proper intervals, without special attention. Any change in the live steam pressure will be followed by proportionate changes along the line. The evaporators will, in fact, automatically space themselves along the pressure line from initial steam to condenser pressure, so that the drop in temperature will be approximately the same in each effect.

Keeping Water Pure

Vapor produced in the evaporators is necessarily pure, and condenses into chemically pure water. Having the power to dissolve almost every substance in some degree, distilled water may become impure almost immediately. Distilled water lines are therefore often of block tin, tinned brass, or brass untinned, as these metals are more or less proof against corrosion. But in many plants black iron pipes are used without affecting the distilled water in the least. The greatest difficulties with the purity of distilled water occur in ice plants.

When 400 lb. of water is frozen into a solid cake of ice, the impurities remain in the uniform center of the can until caught by the final closing of the core. In this way a trace of iron or other impurity in the water is condensed into the teacupful that freezes last, and is likely to appear as a stain or spot of color. It is found that the presence of organic gases, often dissolves in natural water, promote the attacking of the metal by the distilled water. If such gases are not blown out of the evaporator shells, and are allowed to get into the drain lines where the distilled water can again take them into solution, metallic impurities in solution may be the result.

Removing Air and Gases

Venting the air is therefore very important. Evaporators working above atmospheric pressure may be vented through open cocks discharging into the atmosphere. Evaporators under vacuum should be vented into the condenser. The drain traps of the heating tubes should be provided with vent cocks, and those of traps working under vacuum should be connected into the condenser. Removing air is much assisted by pre-heating the raw water in an open heater, before feeding it to the evaporators. Both air and scale-forming substances may thus be in great part removed. All the scale that can be left in the open heater means so much less to be dug and washed out of the evaporator shells.

Ice-making evaporators are often arranged with separate dry and wet vacuum pumps, so as to remove the gases from contact with the water in the condenser as soon as possible. Reboiling with live steam may then be omitted, and an important saving in steam is the result. The cooling water for the steam condenser usually comes from the overflow of the ammonia condenser, and may run as warm as 90 or even 100 deg. The vacuum in the condenser falls off with increased temperature of cooling water, and the temperature of evaporation in the last effect increases accordingly, decreasing the quantity evaporated in that effect and so through all the rest. If the quantity of distilled water tends to run short, the condenser should be given all the circulating water available, so as to increase the output of the evaporating plant.

With water containing particularly troublesome gas, a separate vacuum reboiler may be provided. This is a shell with heating coils within, connected so as to receive all the distilled and condensed water from traps and condenser, and piped to dry air pump and float-controlled wet vacuum pump. The water from the evaporating plant reaches the vacuum reboiler at an average temperature somewhat above that corresponding to the vacuum in the reboiler. The excess of heat causes the water to boil, discharging its gases and some vapor, which passes off through an auxiliary condenser to the dry air pump. The amount of the reboiling is controlled by admitting steam to the heating coils as required, and can be watched from outside the reboiler through sight glasses provided for the purpose.

Cleaning Out

Cleaning evaporators should be attended to regularly. With an 8-effect plant, one shell may be bypassed, cut out and cleaned daily. During the interval, the remaining 7 will produce the full output, with a slight increase in the amount of steam supplied to the first effect. With coil-tube evaporators, scaling the tubes can be done by heating them with live steam and playing cold water from a hose on the tube surface, which cracks off the scale. The most convenient type for scaling purposes is the evaporator with all coils attached to manifolds carried on the interior of the access door of

the shell. With this arrangement, the whole nest of coils can be slid out like a bureau drawer, and the scale can be knocked off on the floor instead of falling into the bottom of the shell. Blowing down each shell at frequent intervals will delay the formation of scale.

Water softeners are as useful with evaporators as with boilers, to remove the substances forming hard scale before they are deposited within the evaporator; but whatever facilities are provided, the man in charge of an evaporating plant must remember that it is not possible to put solids into a shell without some time taking them out again, and that he can save himself labor by attending to blowing and cleaning daily.

Ammonia Plant Efficiency

ACTION IN THE CONDENSER; CAPACITY FOR COOLING MEATS. BY A. G. SOLOMON

IN reading Ammonia Compressor Efficiency, in the Nov. 1 issue, I note one point in particular which needs further discussion.

We are to understand that with a discharge pressure of 190 lb., the temperature of the liquid ammonia leaving the condenser must be 98 deg. F., which is an erroneous idea prevalent with many engineers and students of refrigeration. Many ice machines in operation carry 190 lb. condenser pressure, yet the liquid leaves the condenser at a temperature never exceeding 80 deg. F.

WORK OF THE CONDENSER

WE can easily see how this may be so if we remember that the discharge gas temperature is seldom in accordance with the discharge pressure. This temperature is regulated by the temperature and degree of saturation of the vapor admitted to the compressor, and the discharge can be run hot or cold at the will of the operator.

Ammonia condensers are built with different numbers of pipe to the stand, some of them being 12, 24, 36, or even 48 pipes high. Why are some of them built so high in some parts of the country? Surely not merely to condense the gas into liquid. This is done in a small number of the pipes at the top of the stand. First, the gas enters the condenser and gives up its superheat to the water. Then, as the water takes up more of the heat, the gas begins to condense, and when it reaches a state where the liquid and vapor are at a like temperature, we call it saturated and it is at the temperature referred to in the Properties of Saturated Ammonia. In properly operated plants, this saturated state is reached long before the ammonia gets through the lower pipes of the condenser.

At times the temperature of the ammonia leaving the condenser is even higher than the figure given as corresponding to the pressure, but this should not be. If an insufficient charge of ammonia is handled, the liquid travels too fast and leaves the condenser much hotter than the cooling water used; or if permanent gases are present, they travel with the ammonia and carry heat.

After the ammonia gas has been condensed, the liquid travels slowly through the remaining pipe of the stand and will, upon leaving the condenser, have a temperature the same as the cooling water, or but a few degrees higher.

A double-pipe condenser, 12 pipes high and operated with a full charge of ammonia, which enters the condenser in a slightly saturated condition, will first condense and then cool the liquid so that it will leave the condenser at a temperature the same as the coldest cooling water.

We would not need much condenser surface if the condensing of the ammonia gas were all that is desired. There is no reason, that I can see, why the ammonia passing the expansion valves should not be nearly as cold as the cooling water used.

The temperature of the liquid might be 70 or 80 deg. F. as well as 98 deg. F. when the condenser pressure is 190 lb., depending on the construction of the plant, kind of work done and temperature and amount of cooling water.

REFRIGERATING EFFECT

ANOTHER point is in regard to the latent heat of vaporization. In calculating the efficiency of ammonia, the vaporization is carried on in the evaporating coils and the number of B.t.u. must be taken for the temperature corresponding with the pressure in the coils, and not the temperature of the liquid. At 15 lb. pressure the latent heat of vaporization is given as about 555 B.t.u. Then if the temperature of the liquid passing the expansion valve should be 98 deg. F., we have:

$555 - (98 - 0)\ 1 = 457$ B.t.u. as the refrigerating effect of 1 lb. of ammonia evaporated under those conditions.

Now, to come back to the compressor trouble of L. E. M., stated in the Sept. 1 issue, we should know the size of the rooms, kind of insulation, average weight of cattle, hogs and sheep, whether direct expansion or brine circulation, and the temperature of the cooling water and the amount available. Without this information, we can only guess at what work the compressors are doing.

We will assume that the temperature of the cooling water is 80 deg. F., and that there is plenty of it for condensing purposes. If such is the case, the machines should do good work, other conditions being as favorable. For the making of 1000 lb. of ice, we will allow one ton refrigeration. Average weight of cattle 700 lb. Average weight of hogs, 250 lb. Average weight of sheep, 75 lb. Then we have 7000 lb. beef; 1250 lb. pork; and 750 lb. mutton to cool daily. We do not know at what temperature the meat is put into the coolers, but we will assume that it is all left on the hanging floor until the animal heat is taken out and the meat is about atmospheric temperature. We will call this outside temperature 80 deg. F. average.

We are to cool the beef to 32 deg. F.; specific heat of beef 0.7; pork to 28 deg. F.; specific heat of pork, 0.5; mutton to 32 deg. F.; specific heat, 0.7.

$$7000 \times (80 - 32)\ 0.7 = 235{,}200 \text{ B.t.u.}$$
$$1250 \times (80 - 28)\ 0.5 = 32{,}500 \text{ B.t.u.}$$
$$750 \times (80 - 32)\ 0.7 = 25{,}200 \text{ B.t.u.}$$

Total amount 292,900 B.t.u. to be taken up every 24 hr. Dividing this by 284,000 gives 1.03 tons refrigeration actually required to cool the meat. About as much more will be used in taking care of the loss caused by heat leakage through the walls, the opening of doors, burning lights and the men working in the rooms, making 2 tons refrigeration.

Then this meat and the other product from the animals which are killed will have to be held at the required temperature until disposed of. We can easily allow an additional 2 tons to take care of this. Then 1 ton for ice making; 2 tons for refrigerating the fresh meat, and 2 tons for byproduct and holding of temperatures will amount to only 5 tons refrigerating capacity.

If it requires 2 6-ton compressors to do this work, there must be something radically wrong; or, more likely, both machines are not kept in operation all the time.

Excessive heating of the discharge might be a clue to the trouble. Examine the valves and piston rings, note condition of the cylinders and the surfaces where the safety head makes the top joint. Also be sure that the scale trap on the suction is clean. Put thermometers on the suction and discharge lines and the actual conditions will be readily seen. The only reason I can see for an increased head pressure and discharge temperature when more feed is given, is an insufficient charge of ammonia and the presence of permanent gas. Purge the condensers and then see that the glass gage on the liquid receiver is at least ⅔ full when running with full load.

Defrosting Brine Coils

USING SPECIAL CONNECTIONS FOR WARM BRINE AND A SIMPLE CUTTER. BY KARL HOFFMAN

IN A certain mixed ammonia compression plant, trouble was experienced about the middle of the warm season, through being unable to maintain the required temperature in 2 of the cold storage rooms, where cold brine was circulated through the cooling coils. The doors had to be opened several times during the day, and owing mostly to this, the frost formed rapidly on these coils.

No ante room, or air lock, was provided to protect these entrances, and the cooling surface was not proportioned any too liberally. As nothing could be done by way of increasing the amount of cooling surface, the engineer planned the arrangement of piping illustrated in Fig. 1, to defrost the coils by means of warm brine circulated through them, which if done regularly keeps the coils reasonably clear of frost.

WASHING THE FLOODED SYSTEM

ONE part of this plant is operated on a flooded system, the other on the dry gas system. When this plant was installed the centrifugal pump, and tank, with heating coil inside, was added to the equipment to be used to defrost the coils of the flooded system, which is used in connection with a forced air circulating system. By means of the pump, warm brine is forced into slotted pipes like those sometimes used on atmospheric ammonia condensers. From these the brine overflows onto the coils, and in this manner frees them of frost, connections not being shown in Fig. 1.

WARM BRINE CIRCULATION

THE engineer conceived the idea of using the same pump to circulate the warm brine through the brine coils, and made the connections accordingly. It will be noticed that the cold brine is first passed through a brine cooler whence it passes through the coils to the ice tank, which acts as a surge tank for the brine circulating pump. Shut-off valves for the inlet and outlet of the coils are located at A, A′ and B, B′.

This arrangement, which represents, very nearly, the manner in which the piping is laid out, made it convenient to arrange the cross connections as shown. When circulating warm brine through the coils, the valves used are V, V′, V″ and V‴.

Valve C is used to regulate the flow of warm brine returning to the tank in order to keep it from overflowing. Valves D and E are located as shown simply to prevent the loss of brine in case the pump is removed for any reason.

Chloride of calcium is used in this system, and it has been found that heating the brine to about 75 deg. will defrost the coils in a comparatively short time. When

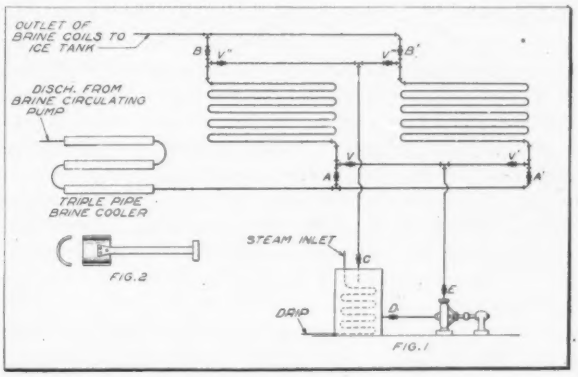


FIG. 1. CONNECTIONS OF THE DEFROSTING SYSTEM

FIG. 2. DEFROSTING TOOL

the frost has been removed, the warm brine remaining in the coils is discharged into the ice tank, whose volume is comparatively large, so that there is no appreciable rise in its brine temperature.

In tracing out the connections it will be seen that either coil can be defrosted without interfering with the operation of the other.

CUTTING OFF FROST

FOR removing the frost a home-made tool, illustrated in Fig. 2, is used. This was made from a piece of flat iron, sharpened at the edge, and shaped to conform to one-half of the outside circumference of the pipes in the coils. The handle is of 1-in. pipe with a cap at the outer end, the other end being flattened and riveted to the round nose piece, as shown.

When a coil is to be defrosted, one of the employes starts at the inlet of a coil, and by using the tool as a cutter, pushes it so that one half of the frost is cut from the pipes. The other half falls off, or is easily knocked off, so that a coil is defrosted in a short time. With the coils defrosted at regular intervals, the efficiency of the coil is, of course, greatly increased. Since the idea has been put into effect it has been found that during the cooler months of the year the cold brine can be shut off from these coils during the night for several hours at a time.

Scientific Kiln-Drying of Lumber*

STRUCTURE OF WOOD; OBJECT OF DRYING; LOSSES DUE TO POOR DRYING; PRINCIPLES AFFECTING DRYING OF WOOD. BY HARRY D. TIEMANN

BEFORE wood is suitable for use for most purposes it must be dried. Dry wood is in a unique condition, since wood in the living tree has never been dry from the time it was first formed. The operation of removing the moisture from wood does not consist of simply evaporating moisture, for if evaporating moisture were all there were to the process, there would be no problem at all; it would simply be supplying the necessary heat. Wood, however, is a complex substance and the removal of the moisture is accomplished by physical and mechanical changes. It shrinks and increases in strength and other changes take place.

It is remarkable that less attention is given to the conditioning of wood for the purpose for which it is to be used than is given any other material. With iron and other metals, the greatest care and the most expert knowledge are used in their preparation. With wood, however, the total value of whose products exceeds that of every other substance except agricultural products, up to the present little expert attention has been paid to the conditioning. The idea seems to have been that Nature will take care of her own and that the wood can be allowed to dry almost any way. When it is considered that the quality of the finished product is in part dependent upon the process that has been used in drying, for any injury produced in the drying process can not subsequently be rectified, the importance of the subject of proper drying becomes evident.

FIBER SATURATION POINT

WATER EXISTS in green wood in 2 forms: As liquid water contained in the cavities of the cells or pores, and as "imbibed" water intimately absorbed in the substance of which the wood is composed. It is almost axiomatic that removal of the free water from the holes or pores will have no effect upon the physical properties or shrinkage of the wood, but as soon as any of the "imbibed" moisture is removed from the cell walls shrinkage begins to take place and other changes occur. The strength also begins to increase at this time. This condition of moisture, which is the point when the cell walls or wood substance becomes saturated, is called the fiber saturation point, and is very significant in the drying of wood.

It is easy to remove the free water from woods which will stand a high temperature, as it is only necessary to heat the wood slightly above the boiling point in a closed vessel which will allow the escape of the steam as it is formed but will not allow dry air to come in contact with the wood, so that the surface will not become dried below its fiber saturation point. This can be accomplished with most of the soft woods, but not as a rule with the hard woods, as they are injured by the temperature necessary. When it comes to evaporating the "imbibed" moisture, and where the free water has to be removed through its gradual transfusion instead of boiling, difficulties arise. As soon as the imbibed moisture begins to be extracted from any portion, shrinkage begins and stresses are set up in the wood, tending to cause checking. The fiber saturation point lies between moisture condition of 25 and 30 per cent of the dry weight of the wood, according to species.

THE WOOD SUBSTANCE

WOOD IS 1.5 times as heavy as water. If wood could be compressed so that all the air spaces were got rid of it would sink like a stone, the specific gravity of the wood substance being 1.5. This substance is the product of living processes; that is, it is organic, and its structure is, therefore, complex. It is thought to be built up of small particles of a substance known as cellulose closely laid together, the interstices being capable of filling up with moisture. Cotton is almost pure cellulose, but in wood there is another material combined with this called lignin, which has never been isolated, but is known only in combination with other substances. Just how it is combined with the cellulose is not known. It adds to the strength of the cell walls and gives them a darker color.

OBJECTS OF DRYING WOOD

THESE MAY be grouped under 3 main headings:

1. To reduce shipping weight.
2. To reduce the quantity necessary to carry in stock.
3. To prepare the wood for use and improve its qualities.

When the wood will stand the temperature, drying to reduce weight is most easily accomplished by heating the wood above the boiling point in a closed chamber but so arranged that the excess steam produced will escape. This process manifestly does not apply to hard woods but is applicable to many of the soft woods. It is used especially in the Northwest, where inch Douglas fir is dried in from 40 to 65 hr., and sometimes in as short a time as 24 hr. In the latter case, superheated steam at 300 deg. F. is forced into the chamber; but, of course, the lumber can not be heated thereby much above the boiling point so long as it contains any free water. The heat of evaporation may be supplied either by superheated steam or by steam pipes within the kiln itself.

The quantity of wood necessary to hold in stock is naturally reduced when either of the other 2 objects is attained and, therefore, need not be discussed here.

In drying to prepare for use and to improve quality careful and technical drying is called for. This applies more particularly to the hard woods, although it may be required for soft woods also.

PRACTICE OF DRYING NOT STANDARDIZED

PRESENT PRACTICE of kiln drying varies greatly and there is no uniformity or standard method. Temperatures vary anywhere from 65 to 165 deg. F., or even higher, and inch stuff 3 to 6 months on the sticks is being dried in from 4 days to 3 weeks, and 3-in. stuff in from 2 to 5 months. Many kilns make a hit at superficial points and fall down on the fundamentals.

*From an address before the Northern Hemlock and Hardwood Manufacturers' Assn.

Methods of Drying and Types of Kilns

All methods in use at atmospheric pressure may be classified under the following headings. The kilns may be either progressive or compartment, and preliminary steaming may or may not accompany any one of these methods:

1. Dry air. Generally obsolete.
2. Moist air.
   a. Ventilated.
   b. Forced draft.
   c. Condensing.
   d. Humidity regulated.
   e. Oven or boiling.
3. Superheated steam.

Losses Due to Poor Drying

In some cases, there is practically no loss, but more often it ranges from 1 to 3 per cent, and 7 to 10 in refractory woods such as gum. In some cases, the losses are as high as 33 per cent. Air drying is by no means always to be preferred, as there is little or no control over the process; it may take place too rapidly some days and too slowly others; it may be very irregular. Hard woods in large sizes almost invariably check, but by proper kiln drying these unfavorable circumstances may be eliminated. Air drying is, however, unquestionably to be preferred to bad kiln drying, and when there is any doubt in the case it is generally safer to trust to the latter. Green lumber can be better dried in the kiln if the fundamental principles are all taken care of.

Proper Kiln Drying vs. Air Drying

Some of the advantages of kiln drying to be secured over air drying in addition to reduction of shipping weight and lessening quantity of stock are the following: Less material lost. Better quality of product. Prevention of sap stain. Fixation of gums and resins. Reduction of water absorption.

Experiments have shown that drying oak and ash at 145 to 170 deg. F. has reduced the water absorption 15 to 25 per cent. Specimens from the same sticks were both air dried and kiln dried, then placed side by side on a rack for over a year, and their moisture contents then determined. This reduction in moisture means a reduction in the "working" of the materials which, even though slight, is of great importance.

Fundamental Principles of Drying of Wood

Evaporation from the surface of a stick should not exceed the rate at which the moisture passes from the interior to the surface.

2. Moisture tends to pass from the hot toward the cold portions.

3. Wood is soft and plastic while hot and moist and will become set in whatever shape it is in as it dries.

4. Shrinkage is greater the higher the temperature of drying while still moist.

5. Casehardening and honeycombing result from the 2 foregoing circumstances. It may be explained thus: Suppose a block of wood is very wet and is placed in at too high a temperature and too low a humidity. The surface begins to dry and tends to shrink, but is prevented from doing so by the wet interior. Being plastic, it yields to this resistance and becomes stretched, and if not plastic it will check open. As drying proceeds, it becomes hard and set in this expanded condition and acts as a strong shell. The interior now dries very slowly, does not become set but shrinks, and as the exterior is already hard it opens up into honeycombing. When the exterior once becomes set, or casehardened, the interior is almost certain to become honeycombed, whether the drying takes place in the kiln or a long time afterward, and the only remedy is to moisten the exterior by steaming or soaking before it is too late. Air-dried, as well as kiln-dried, material frequently casehardens and honeycombs.

6. Drying should take place uniformly at all points; otherwise stresses are set up in the wood.

7. Brittleness is produced by drying too far.

8. Dried wood absorbs or loses moisture in proportion to the relative moisture in the air.

9. Water absorption and working are reduced by thorough drying but not eliminated.

To utilize these principles properly in drying, attention should be given to the following factors:

1. The lumber should be heated clear through before drying begins.

2. Humidity should be correct at the start and reduced in the proper ratio as the drying progresses.

3. The temperature of the lumber should be uniform and as high as the kind of material will endure.

4. The rate of drying should be controlled by the amount of humidity in the air and not by the rate of circulation. The circulation should be ample at all points to supply the heat needed for vaporization and to keep the humidity uniform. To evaporate one pound of water at atmospheric pressure requires the amount of heat given up by 69,000 cu. ft. of dry air in falling 1 deg. F. The regulation of the humidity is to prevent the surface from drying down to the point where it takes a "set" before the interior has dried to nearly the same amount, thus preventing casehardening. If dried too rapidly, casehardening will result.

5. The degree of dryness obtained should conform with the use to which the wood is to be put.

Ideal drying depends upon ample circulation, control of humidity at all times, and proper temperature. Any kiln which fulfills these conditions should be capable of giving perfect drying.

Notable for its effective methods of manufacture, the Ford Motor Co. of Detroit considers one of the most important factors in its success the detail with which the health and comfort of employes is looked after. Acres of factories and miles of floor space are heated and ventilated to give the best conditions for efficient working, the latest installation being a 6-story addition with 65 per cent of the wall surface glass; yet in winter 70 deg. and in summer 78 deg. are maintained by a perfect system supplied by Sirocco fans located in pent houses on the roof. Here the air is purified and conditioned for temperature and moisture, then sent down through the hollow columns which support the floors.

Heat is obtained from the jacket water of gas engines and air compressors pumped from the power house, with additional heating when needed, from steam coil water heaters. The same pipes carry cold water in summer for cooling the air.

XUM

Power Transmission Economics

Relative Power, Speed and Cost of Cast-Iron and Steel Spur Gears with Cast or Cut Teeth. By Reginald Trautschold

WHERE space is limited, transmission of power and reduction in speed of revolution frequently makes reliance on gearing necessary. When the shafts are parallel, spur gearing is resorted to; while if the shafts meet at an angle or do not lie in the same plane, miter or angle gears are used; worm gearing is employed when great reductions in speed are required; etc., etc. Common as is this method of power transmission, it is one that presents more examples of inefficient design than any other system, due partly to ignorance of the principles of gearing and partly to the fact that the choice of available gears on the average market is not as extensive as it should be, leading to the use of any gears procurable that will give the proper speeds, irrespective of whether properly proportioned for the service demanded or not—provided they are strong enough.

Gears capable of transmitting 50 to 100 hp. will be found in many installations calling for the transfer of but 10 or 20 hp., an economic waste just as much as employing 4 or 5 horses to do work that could be done just as efficiently and expeditiously by 1 horse. It will therefore be the object of the present discussion to treat with the general principles of gearing economics and in order to simplify the scope of the article, plain spur gearing will first be considered.

Power Transmitted

Power capacity of any gear is dependent upon the force exerted upon its teeth and the speed at which the gear travels, or, in other words, the horsepower of a gear depends upon the strength of its teeth and its revolutions. The strength of the tooth depends upon its proportions, its design and its width, and the material of which the gear is constructed. As for the design of the tooth, the recognized standard is an approximation of the epicycloidal type and such will be considered alone throughout this discussion. The materials of which the gear may be constructed are, of course, many, but for practical purposes may be limited to cast iron and cast steel. This elimination of all special gears greatly simplifies the question but does not make it as simple as the plain conditions governing the power capacity of a gear would indicate.

In the first place, though the power of a gear depends directly upon the width of its teeth—provided the teeth are wide enough to develop their legitimate strength—the power that it can transmit at a given speed is not directly dependent upon its circular pitch—the distance from center to center of teeth on the pitch line—but increases somewhat more rapidly than does the pitch. Neither does the speed of the gear directly govern the power it can transmit. The power does increase with the speed, but the increase becomes less and less as the speed of rotation becomes greater. These vagaries make it difficult to devise a reliable formula for ascertaining the horsepower of gearing, the various formulas usually accepted differing greatly in their results, so that the conservative manufacturers of gears depend upon tests for such data, which they incorporate in gear tables from which suitable gearing may be readily selected.

These actual tests, or records, differ considerably among manufacturers, however, and dependence upon horsepower charts plotted from average results secured by the numerous tests of several manufacturers is much more reliable. Such records are presented as Charts XIV and XV of the Reference Tables, which give the horsepower of standard cast iron and steel spur gears per inch face, width, when traveling at 100 r.p.m., with cast and cut teeth respectively. Chart XVI gives the "horsepower factor" for gears run at various speeds by which the horsepower readings given on Charts XIV and XV should be multiplied to ascertain the power of the gears at speeds other than 100 r.p.m.

Choosing Gears

In choosing suitable gears where 2 or more gears mesh with one another, the gear proportions must be chosen for the pinion, or smallest gear, for the strength of the train is that of the smallest unit. The larger gears will usually be unduly strong, of course, for their face width must be as great as that required for the pinion, as the tooth strength of the latter is dependent upon uniform distribution of stress over the face of the tooth. This rule is subject to possible exceptions, if the revolutions of the pinion are greatly in excess of those of the largest gear, so that it is always well to check proportions by also seeing whether the strength of the gear is ample for the service to which it is to be subject.

Though the width of the gears must be based on that required for the pinion, in the majority of cases, it must not be forgotten that the diameter or number of teeth of the pinion is governed by the size of the largest gear, the diameter of which is in turn limited by the practical tooth speed at which it can be run. For gears with cast teeth, this is limited to about 900 ft. a minute, and for gears with cut teeth, to about 1600 ft. a minute. These limiting speeds fix the maximum size of gear and the number of teeth of a given pitch, that can be employed.

As the width of the gear depends upon the necessary face for the pinion, and this face decreases as the diameter of the pinion increases, it is always well, when feasible, to choose the largest gear that can efficiently be employed and proportion the pinion accordingly, as by so doing the face of the pinion will be a minimum and the power of the gear more nearly developed. When there is considerable difference in diameter between the pinion and the gear, shrouded pinions, with encircling disks binding the teeth together, are employed; the shrouding increases the strength of the teeth, thus reducing the width of the pinion below what would otherwise be necessary, reducing the cost of the gear at the same time and permitting its capacity to be more nearly realized.

Standard practice in the design and construction of gears somewhat complicates the choice of efficient gearing, for it is always well, from the point of economy, to

choose a gear as near to standard proportions as possible, though a more efficient gear might be devised. The face of the standard gear is from 2 to 3 times its circular pitch, the smaller multiple referring to gears of comparatively fine pitch. These proportions are necessary to develop the full or legitimate strength of the gear teeth and should rarely be lessened, although the face of gears may be increased beyond the standard when necessary,—such change usually resulting in making the gear somewhat unreasonably expensive, so that it is always advisable to use gears of as near standard proportions as possible. The generally accepted proportioning of spur gears of common pitch is given in the table herewith.

By superimposing curves indicating the limiting practical diameter of gear at various speeds on the horsepower charts, XIV and XV, all the data required for the economic choice of gearing is presented.

PITCH AND FACE OF STANDARD SPUR GEARS IN INCHES

Circular Pitch	Face	Circular Pitch	Face	Circular Pitch	Face
½	1	1¼	3	2½	7½
⅝	1¼	1½	4	2¾	8
¾	1½	1¾	5	3	9
⅞	1¾	2	6	3½	10½
1	2	2¼	7	4	12

Example

This is best illustrated by a simple example and it will be assumed, therefore, that it is required to transmit 50 hp. from a shaft making 200 r.p.m. to a parallel shaft traveling at 100 r.p.m., a gear reduction of 2 to 1. Considering gears with cast teeth first—see Chart XIV—the largest gear of finest efficient pitch, ⅞ in., that could be employed would be one with 124 teeth; while the largest gear of heaviest ordinary pitch, 4 in., would have 27 teeth. Within these limits, the number of teeth required for the most efficient gear would be as follows:

Pitch, In.	⅞	1	1⅛	1¼	1½	1¾	2	2¼
Teeth	124	109	97	87	72	61	54	48
Pitch, In.		2½	2¾	3	3¼	3½	3¾	4
Teeth		43	39	36	33	31	29	27

all of which would have nearly the same pitch diameter.

The smaller gear, meshing with this large gear, would have but half this number of teeth—the reduction being 2 to 1, and would have to make 200 r.p.m. At this higher speed, a gear would transmit about 45 per cent more power than it could at 100 r.p.m.,—see Chart XVI,—so the efficient pinion need be capable of transmitting but 34.5 hp. at 100 r.p.m. To transmit this power, a ⅞-in. pitch, 62-tooth gear with cast teeth would have to be 11½ in. wide if of cast iron, or 4½ in. wide, if of steel. The suitable 4-in. pitch gear with cast teeth would be for cast iron 5½ in. wide, or for steel 2¼ in. wide. None of these gears would be economical for they all vary too greatly from the respective standard gears of such pitches as given in the table, or at the bottom of Chart XVIII, the gears with fine teeth being altogether too wide and those with heavy teeth too narrow.

Examination of the proportion requirements of gears of other pitch, that are capable of most economically performing the work required, shows that in the case of cast-iron pinions, the one nearest standard proportions would be a 27-tooth, 2-in. pitch gear 7 in. wide; in the case of steel pinions, the nearest standard would be a 43-tooth, 1¼-in. pitch gear 3½ in. wide. These gears are both slightly wider than standard but not so much so as to necessitate bad proportions. Referring to Chart XIV for the power of gears of double the number of teeth revolving at 100 r.p.m., the requirements for the larger of the 2 gears constituting the train, it is seen that either the cast-iron or the steel gear of the width required for the pinion would be able to transmit more than 50 hp., so that the most efficient combination for the installation under consideration would be: for cast-iron gears, a 54-tooth, 2-in. pitch, 7-in. face gear meshing with a 27-tooth pinion of similar pitch and face; for cast steel gears, an 86-tooth, 1¼-in. pitch, 3½-in. face gear running with a 43-tooth pinion.

Similar investigation with Chart XV for economical gears with cut teeth shows that for cast-iron gears the most economical combination, without exceeding 140 teeth for the gear, which is about the limiting number of teeth for standard gears of usual pitch, would be; for cast-iron gears, a 140-tooth, 1¼-in. pitch, 3¼-in. face gear meshing with a 70-tooth pinion of the same pitch and face; for steel gears, a 140-tooth, ⅞-in. pitch, 2¼-in. face gear engaging a 70-tooth gear of the same width.

Comparative Costs

All of the foregoing combinations of gears are about equally good as far as correct proportioning is concerned and the advisable choice between them would be almost entirely a matter of first cost, all combinations being about equal in wearing qualities, depreciation, etc. Dependence upon manufacturers' gear price lists for costs of gears has the decided disadvantage that just the gears required may not be listed, and though the manufacturer could supply the exact gear wanted, even if its face was slightly in excess of the standard, at a reasonable price, the ordinary salesman is wisely disinclined to accept the responsibility of quoting upon anything for which he has not the exact price. This is one reason why improperly proportioned gears are sold and installed.

Actually there is a fairly constant relation governing the cost of standard proportioned gearing based on the number of teeth of given pitch and also a fairly constant increase in cost for proportional additions to the face of the gear. A gear with twice as many teeth of the same pitch and face as another does not cost twice as much, though twice as large in diameter, but there is a relation for each pitch of standard width of tooth. Taking the cost of a 10-tooth gear as unity, the proportional cost of any cast-iron gear (cast teeth) of more teeth and standard width is shown on Chart XVII, Practical Reference Tables. For instance, a 100-tooth gear of 1-in. pitch and 2-in. face costs about 6½ times as much as a 10-tooth gear of the same proportions, while a 100-tooth gear of 1¾-in. pitch and 5-in. face costs about 11 times as much as a similar gear with only 10 teeth. The standard 10-tooth, 1-in. pitch gear does not cost the same as the standard 10-tooth, 1¾-in. pitch gear, however, but there is a comparative relation between such costs.

Chart XVIII gives the comparative cost of standard cast-iron gears (cast teeth) of various pitch, the base

of comparison being the cost of a ¾-in. pitch, 1½-in. face, 10-tooth gear taken as unity, from which it is seen that the comparative costs of 10-tooth standard gears of 1-in. and 1¾-in. pitch are 1.17 and 1.93 respectively. The comparative costs of 100-tooth standard cast-iron gears (cast teeth) of 1-in. and 1¾-in. pitch are then $1.17 \times 6.5 = 7.60$, and $1.93 \times 11 = 21.23$ respectively.

These comparative costs apply to cast-iron, cast-teeth gears only; but there is a somewhat similar relationship for cast-steel gears and for both kinds of gears with cut teeth. This is graphically shown on Chart XIX. The "Relative Cost" readings of this chart give the factors for multiplying the comparative costs of cast-iron, cast-teeth, gears for arriving at the comparative costs of steel gears or gears with cut teeth. Such costs apply only to gears of standard proportions, and, if the gear is wider than standard for its pitch, another charge must be added. This extra charge is very nearly constant for each tooth, per inch additional width for the various types of gears and is graphically given on Chart XX. The "charge" readings of this chart give the multiplier, per tooth, per inch width other than standard, for arriving at the amount to add to the "Comparative Cost" of gears of standard face.

With these "comparative cost charts" it is a simple matter to arrive at a reliable opinion of the relative economies of the 4 sets of suitable gears selected for transmitting 50 hp. from a shaft at 200 r.p.m. to a parallel shaft making 100 r.p.m.—see Example. The cast-iron gears with cast teeth are the cheapest, as would be expected, but only about $4.10 less expensive than steel gears with cast teeth, at the present market price of such gears. If the more efficient and more smoothly running cut-tooth gears are advisable, steel cut gears would cost less than cast-iron gears with cut teeth, the balance in favor of the steel gears being about $4.85.

The same relative economies would not, in all probability, exist in any other combination of gears, but the example serves as an excellent illustration of carefully analyzing each individual gear installation and properly proportioning the gears as well as using wisdom in their selection. The ordinary procedure in a case, such as the one considered, would be, if gears with cast teeth were unsuitable, owing to their heavy pitch and accompanying noise, to jump to the conclusion that cast-iron, cut-tooth gears would be advisable, thereby wasting $4.85, as has been seen. In some other installation, cast-iron, cut-tooth gears might be more economical than cut steel gears; in fact, ordinarily such would be the case. The vagaries of gearing are many and must be taken into consideration if economic efficiency is to be realized.

Example

Required comparative (not actual) costs of the following spur gear combinations:

A. 1 54-tooth, 2-in. pitch, 7-in. face gear, cast-iron with cast teeth and 27-tooth gear to mesh.

B. 1 86-tooth, 1¼-in. pitch, 3½-in. face gear, steel with cast teeth, and 43-tooth gear to mesh.

C. 1 140-tooth, 1¼-in. pitch, 3¼-in. face gear, cast-iron with cut teeth, and 70-tooth gear to mesh.

D. 1 140-tooth, ⅞-in. pitch, 2¼-in. face gear, steel with cut teeth, and 70-tooth gear to mesh.

For A: From Chart XVII, 54-tooth, cost is 6 times base, or 10-tooth; and from Chart XVIII, 2-in. pitch, with standard 6-in. face cost is 2.3 times base or ¾-in. pitch gear. The cost compared to a ¾-in. pitch 10-tooth gear would then be $6 \times 2.3 = 13.80$ times as much. Extra charge for 7-in. face over 6-in. standard, 1 in. variation would be from Chart XX 0.0395 per tooth, or for 54 teeth, 54 times that, or 2.13, which added to 13.80 gives 15.93, as comparative cost of 54-in. gear for case A.

Likewise for the 27-tooth gear, from Chart XVII is 2.75 times standard 10-tooth and from Chart XVIII, 2-in. pitch with 6-in. face is, as before, 2.3 times standard ¾-in. pitch with 1½-in. face. Comparative cost would then be $2.75 \times 2.3 = 6.33$; and for the extra 1-in. width for the 7-in. face, $0.0395 \times 27 = 1.06$. Added to 6.33 this gives 7.39 as comparative cost of the 27-tooth for Case A. The sum of the costs of 54-tooth and 27-tooth, $15.93 + 7.39 = 23.32$ as comparative cost of gear and pinion for Case A.

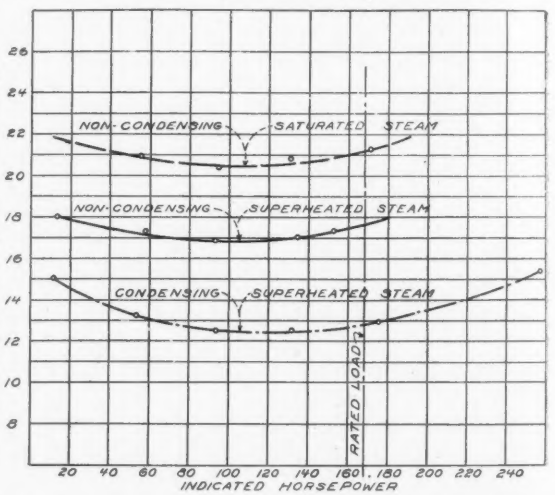
In like manner comparative costs are found for Cases B, C and D, the only difference being that these costs must be multiplied by the factors from Chart XIX to give the added cost for other than cast-iron gears with cast teeth. For instance, for Case C, for a 140-tooth gear, the comparative cost of cast-iron, cut tooth gears is 2.1 times that for cast tooth, and for 70-tooth gear, 2.2 times cast tooth.

Tabulating, we have the results as shown on the summary in Reference Tables.

Unaflow Engine Tests

Ames Iron Works, of Oswego, N. Y., is placing on the market a Uniflow engine, manufactured under the patents of the Stumpf Unaflow Engine Co.

In a recent test, a 100-kw. unit, having an engine of 15 in. bore, 16 in. stroke and running at 250 r.p.m., gave the results as shown by the economy curves herewith.



STEAM CONSUMPTION OF 100-KW. UNAFLOW ENGINE UNDER DIFFERENT CONDITIONS

The figures are not available for the steam pressure, nor for the amount of superheat; but it will be noted that the economy curve is very flat, and that running under any one of the conditions shown on the curves, the engine could be used from ½ load up to 20 per cent overload, with a variation of not over ¾ lb. per hp.-hr. in the steam consumption.

LETTERS DIRECT FROM THE PLANT

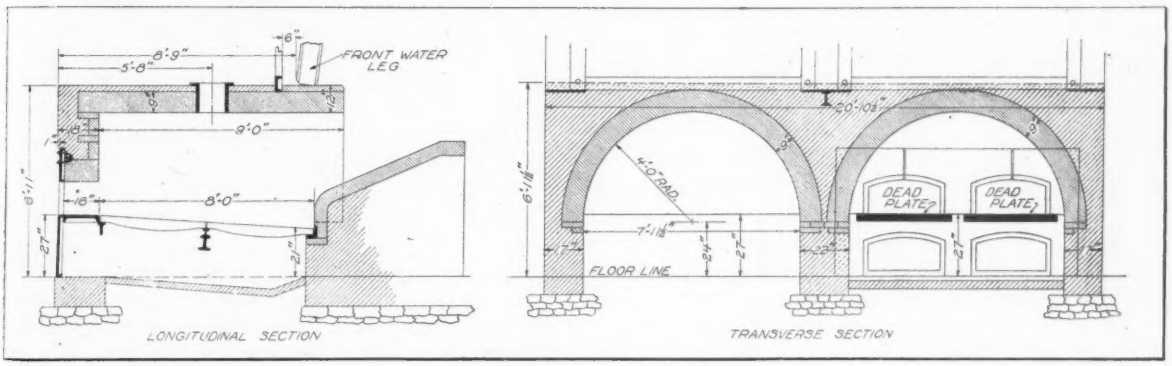
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Furnace for Mixed Fuel

SOME TIME ago, a reader asked for details of a dutch oven furnace for steam boiler work. Herewith are general outline drawings showing the size and construction of a pair of furnaces under 2 280-hp. Erie City horizontal water-tube boilers. These furnaces are fired with coal, wood shavings and sawdust, and work very satisfactorily.

Sawdust and shavings are sometimes fed to the furnaces through the opening in the top, by the dust collector system, in sufficient quantities to make all the steam required. At other times, shavings only are fired by hand through the front furnace doors.

Sometimes wood blocks, cuttings, shavings, etc., are fired, and sometimes wood only, and when there is no refuse they are fired with coal, these furnaces working very well under all conditions.



SECTIONS OF DUTCH OVEN FURNACE FOR MIXED FUEL

The center support is a standard shape of cast iron. The location of the front water leg is shown. The tubes are 4 in. by 18 ft. H. W. BENTON.

Corliss Engine Valves, Cutoff and Governing

IT IS but natural that where many men are engaged in a similar business in widely scattered communities with a great diversity of mechanical appliances, and all laboring under dissimilar conditions, there must also be a similar range in beliefs, thoughts, opinions and experiences, and the writer is presenting his criticisms at this time with the friendliest spirit for those whose excellent articles referred to are made the subject of comment, and trusts that they will be received in the same charitable manner.

In Practical Engineer of Nov. 15, page 1127, there appears in the second column a reference to why exhaust valves are not located at the top of a cylinder and the steam valves at the bottom, where the steam pipes come up through the flooring.

There is one law of nature that must be reckoned with in this great field of mechanics, and which is not recognized as fully as it should be; that is the law of gravitation. And while some Corliss engine builders construct their valves a running fit in the port, so that inverted action might be possible, most of them permit a looseness which will permit the valve to be raised from its seat as much as half an inch.

Thus it is that when steam pressure is not actually holding the valve to its seat, operation in an inverted position, as suggested by the article referred to, would be impossible, for when steam pressure is absent, gravity would cause the valve to fall away from the seat and, even assuming that it could be induced to remain on the seat until the steam pressure would be high enough to hold it there, the moment that the valve is opened, it becomes balanced, and being such, gravity will assert itself.

Again, assuming a Corliss steam valve to operate at all other times, the instant the valve closes, the pressure in the chest and in the cylinder being equal (steam being admitted to the cylinder at boiler pressure) and this pressure being equal on both sides of the valve, gravity would again assert itself.

With the exhaust valves placed at the top of the cylinder as suggested, the intermittent pressures to which these valves are subjected, would make their operation a mechanical impossibility.

With a full cylindrical valve a running fit, an engine could be constructed to operate in the reverse manner as at present; but there would be no real reason for so doing, nor any gain; in fact, the reverse would result owing to the inability of the cylinder to free itself from

the water of condensation, which is one of the ever present evils to be overcome, is much reduced by the use of superheated steam, and in the present 4-valve engines naturally drains off through the exhaust valve, that being the lowest point.

On page 1128 of the same issue, Catechism of the Corliss Engine, the answer given to the first question (No. 54), "What is the range of cutoff in a double eccentric engine?" the answer to which is "Full stroke," while it is possible to set the valves of a double eccentric Corliss engine so as to obtain a cutoff of 100 per cent of the stroke, it is never done in practice in any prime mover except in a case of one having a valve without either lap or lead, the best instance of which is the time-honored duplex pump, which takes a card, the opposite sides of which are practically parallel.

If an engine of the Corliss type with double eccentrics were to cut off actually at full stroke, maximum, the exhaust valve would open before the steam valve at that end would close and permit steam from the boiler to blow straight through into the exhaust. And while a long range cutoff is wasteful in taking care of peak loads with regulation, shooting live steam through the engine at every stroke would be adding insult to injury and bankrupt the firm all too soon.

Still, as has been said, it can be done; but it means retarding release until the piston has at least reached the end of the stroke, or even a little later, for no matter how prompt the dashpots or other similar devices are, it takes time for them to function properly, and if cutoff occurred precisely at the end of the stroke, the actual moment of valve closure would be a fraction of a second later, and the greater the rotative speed, the greater would be the aggravation of this delay, other things being equal.

The writer has obtained excellent cards from Corliss engines running 175 r.p.m., cutting off actually at 82 per cent of the stroke, and releasing at 97 per cent, yet at that great range the dashpot action was barely prompt enough to have the steam valve closed by the time the exhaust valve opened.

Question 58, referring to the gag-pot on most governors, asks, in closing, "What is its use?" The answer referred to gives the general idea of construction, bypassing the oil, and the grades of oil to be used, but overlooks the actual use of the gag-pot.

It is a fact, possibly not fully realized by some, that the best regulation in an engine is at that point where the over-sensitiveness of the governing device has been reduced just inside the point where "racing" or "hunting" occurs. The farther you get inside this line, the more sluggish will be the regulation.

So on most Corliss engine governors (and also on some shaft governors) a gag-pot is placed so that its vertical movement is coincident with that of the governor counterpoise, of whatever design it may be. If there is no restraining device, any change in load, up or down, will cause the governor to "overstep" its required position, and a gag-pot filled with oil is provided to permit a certain restraining influence on the governor when it has reached the precise point required by the change of load.

It has not been the writer's practice to use a heavy oil. In fact, for most cases, very light engine oil or dynamo oil has served the purpose best, and if only a heavy grade of oil is available, it is thinned with kerosene, and the bypass device opened as much as possible so as to bring the governor just within the racing point. Under certain conditions with a free moving but well constructed gag-pot, air alone will suffice, yet the writer has had to travel several hundred miles for the sole purpose of filling the gag-pot with oil, and the resulting steady lights caused the much abused consumers to phone into the power plant to inquire the cause of the "trouble."

Again, in Question 59, while the writer of the article in question refers properly to permanent changes in Corliss engine speed by changing the ratio of the governor pulleys, yet the closing sentence of the answer, "If the change is only temporary, there are a number of ways, all leading to the same end—adding weight to the governor balls," will bear some investigation.

The question is, "How may the speed of a Corliss engine be changed?"

According to the answer, "Adding weight to the governor balls," one might be led to believe that this would be the proper remedy whether one wanted to increase or decrease the speed.

As a matter of fact, this remedy is not universal in its application. In the old style governors, where all the weight is in the balls, other things being equal, and difference in the weight of the balls will not affect the plane of rotation described by the center of the balls.

On the other hand, where the governor is provided with some form of dead weight, or counterpoise, any change in the weight of this will change both the speed of rotation and the sensitiveness, as we get farther from the proper speed at which the governor was designed to give the best service. The shifting weight on a bar, or the small round weights to be added or removed, in order to increase the weight of the counterpoise for temporary changes in speed, are familiar to most engineers.

GEO. H. WALLACE.

Trouble with Oiling System

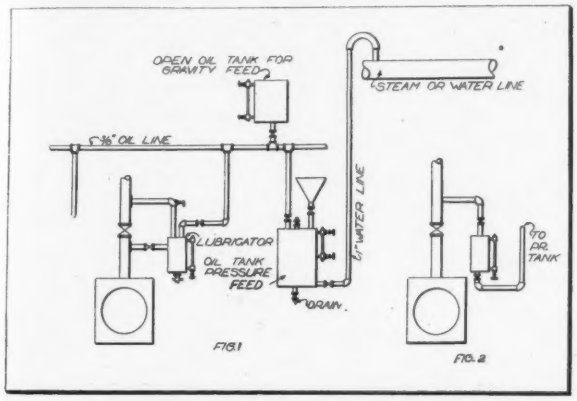
IN REGARD to the trouble W. F. is having with his cylinder oiling system, it seems to me that he has destroyed the principle of operation of this type of lubricator; viz., the hydrostatic head. The sketch and description state that a 10-gal. tank is placed above the header, and connected thereto from the bottom of the tank. The angle valve shown at this point in the sketch would, of course, have to be kept closed to prevent oil from draining into the header. How, then, is the oil going to be forced out of this tank to the lubricators?

A lubricator of this kind operates, due to the unbalanced pressure on the 2 sides of the needle valve, caused by the hydrostatic head of water in the condenser chamber and steam pipe connected thereto. In his case both sides of the lubricator are connected to the oil line, and the pipe that should be filled with water contains oil. This in itself would prevent it from working. There are several ways in which this system may be connected up, but the one that I have found best is as follows:

Place the 10-gal. tank in any convenient position for filling either above or below the header; from the bottom of the tank run a vertical 1-in. pipe about 15 ft. high and loop over to the steam line. This pipe will be full of water, and will produce the required pressure to

operate the feed. The vertical pipe does not have to be exactly 15 ft.; but this height will give a hydrostatic pressure of about 6.5 lb., enough to force the oil out of the tank and into the lubricator. Put a pet cock on the top of the tank and connect the filling plug funnel to the top of the tank or into the discharge pipe near the tank with a valve in the line below the funnel. Put a valve at the bottom of the vertical pipe, and a drain valve between it and the tank to draw off the water, when filling the tank with oil. Place a valve in the discharge line close to the tank and run a ⅜-in. oil header with ¼-in. branches to each lubricator.

The lubricator may be arranged in 2 ways. The alternate feed and fill, and the constant feed and fill. In the alternate method connect the lubricator to the engine in the usual manner, with 2 connections to the steam line, a double connection being more reliable than the single. Connect the oil line to the filling plug with a ¼-in. valve near the lubricator and operate the lubri-



REMEDY FOR OILING SYSTEM TROUBLE

cator in the usual manner. When empty, close the feed valve and the valve in the top of the lubricator, open the drain valve and fill by opening the valve in the oil line. Figure 1 shows the connections to this lubricator. In the continuous method of feeding, connect the lubricator as before for rigidity; but instead of connecting the oil line to the filling plug, connect it to the drain plug, with a valve close to the lubricator. Close the valve in the steam line and leave the oil valve and the discharge to the cylinder open.

The hydrostatic pressure in the oil line plus the steam pressure, will cause the oil to feed through the needle valve. In the first case, it is not necessary to have the oil in the tank under steam pressure, as it will flow into the lubricator by gravity if the tank is placed above the lubricator and vented.

With the tank under steam pressure, the lubricator body may be dispensed with entirely and the sight feed connected as shown in Fig. 2. This feeder consists of a polished rod about 4 in. long threaded on each end for a ½-in. tee which is screwed on each end. Into the side outlet of these tees, screw the top and bottom connections of the sight feed taken from a common Detroit or similar lubricator and put in the glass. Connect the top tee of the feeder to the steam pipe or cylinder for feeding in the usual manner, and connect the bottom of it to the oil line which is under boiler pressure. Place a valve on each side of the feeder, fill the glass with water or glycerin and adjust the needle valve with both valves open. If these systems do not work as they should, give the tank a little more pressure by raising the water pipe.

In the first case of alternate feeding and filling, the oil tank and piping need not be under a high pressure, as a few pounds will operate the system, or it may be operated by gravity if the tank is placed above the lubricator. In the second system of continuous feeding, the whole system is under high pressure, and in case a feed glass breaks, considerable oil may be wasted. For that reason, I prefer to use the alternate feeding and filling. In cold weather, if the oil tank is subjected to cold drafts, place a steam coil in the tank to keep it warm. J. C. HAWKINS.

IN LOOKING over the diagram of W. F.'s oiling system, I believe the trouble lies in the connection made between the 10-gal. tank and the receiver. The pipe, being short, does not allow the steam to condense before replacing the oil in the tank, which has been forced to the lubricators. Also, if it does condense, it would be free to flow back to the receiver, as he states that the bottom of the oil tank is even with the receiver.

By placing the top of the oil tank at a level with the top of the receiver and using the same connections, that is, by connecting the pipe from the top of the receiver to the bottom of the oil tank, I believe the system would work as successfully as any. F. A. STOOS.

Odd Devices in Power Plants

FOLLOWING are a few illustrations of what an engineer who does not remain in the same job for 40 yr. will come in contact with; in fact, the engineer who changes often will bear me out in the statement that the

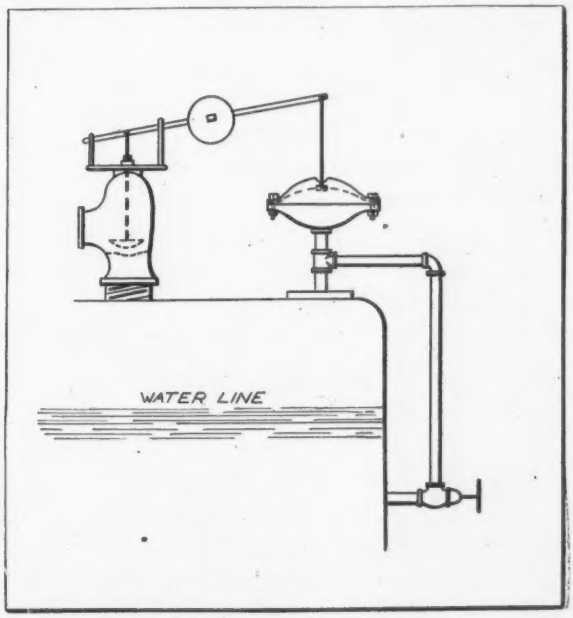


FIG. 1. LEVER SAFETY VALVE WHICH WILL NOT STICK

saying, "A rolling stone gathers no moss," does not hold good when it refers to the engineer who shifts often to get practical knowledge.

In Fig. 1 will be seen a form of safety appliance which is so arranged that if the valve should stick on the seat, the diaphragm will compel the valve to lift; this safety valve was used only on low-pressure boilers in former years. Figure 2 is another form of safety valve which is operated by the steam pressure, which forces the water out of B, up pipe C, and the water runs into pipe A and allows steam to escape at top of C, which

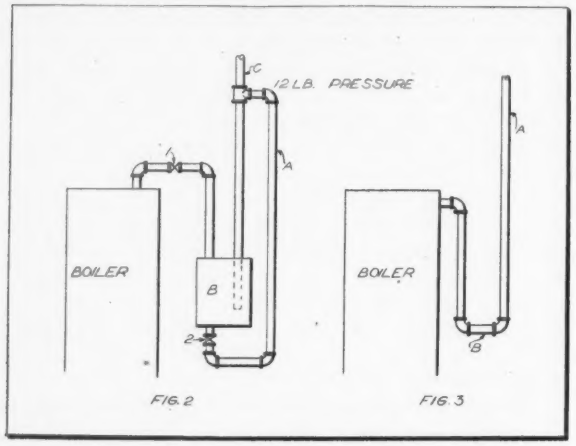


FIG. 2. WATER SAFETY VALVE FOR LOW PRESSURE
FIG. 3. WATER SEAL LIMITS BOILER PRESSURE

will continue blowing until steam is all gone, unless valve 1 is closed and 2 is open, which will allow water in A to fill B, and all is ready again after opening 1 and closing 2. The pressure at which the boiler will blow is, of course, governed by the height of pipe A, which retains the water; pressure is usually about 12 lb.

Figure 3 is a simpler arrangement on the same prin-

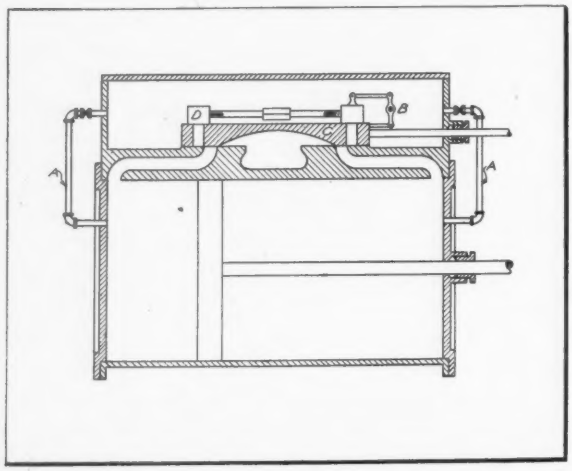


FIG. 4. UNUSUAL TYPE OF CUTOFF VALVE

ciple that water remains in the loop, B, and steam pressure forces water up A and escapes. Both of these boilers were doing good work before the Massachusetts laws came in force.

Figure 4 is an unusual type of riding cutoff with one eccentric, which carries the main valve, C, while the rider valve, D, is moved by the short link, B, which is secured by a center stud inside the steam chest. The disadvantage of this method is that, to get an earlier cutoff, we advance the main valve, C, giving more lead which, because of the link, B, throws rider valve, D, the opposite way, causing an earlier cutoff. The pipes A-A are rarely seen on a riding cutoff engine, but are put there to get steam into the cylinder after the rider, D, has cut off steam, usually 5/8 stroke.

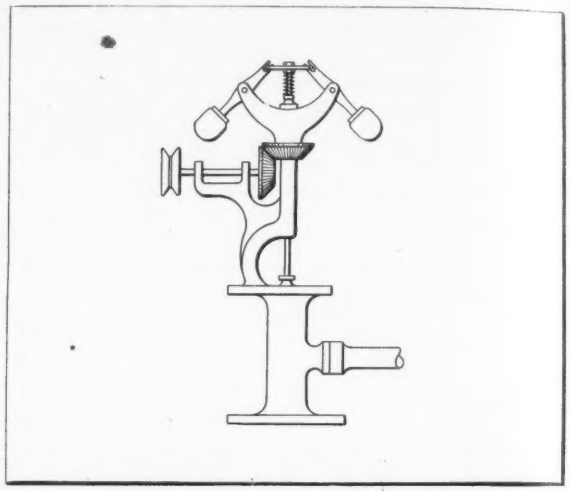


FIG. 5. FAN GOVERNOR

Up to 3 yr. ago, this engine, a 12 by 15-in., ran a soap factory, giving good service. It had a fan governor like Fig. 5, which ran at 758 r.p.m., giving good regulation when the stuffing box on valve stem was not set down too hard.

Figure 6 is a rare type of B valve, which is an indirect valve because, to admit steam, it has to be moved in

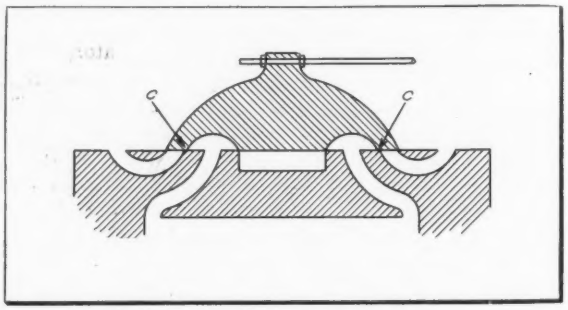


FIG. 6. INDIRECT B VALVE

a direction opposite that of the piston. Steam lap is added at C. There are no special features claimed for this valve, but I found this engine, after 23 yr. of service, still apparently good for as many more.

A. C. WALDRON.

Corliss Engine Lap Correction

IN THE article on Lap of Steam Valves on a Corliss Engine, in the Dec. 1 issue, the writer omitted certain words. The sentence should read, "Being greater, the nearer the eccentric is to the crank, in case the eccentric leads the crank; if the eccentric follows the crank, the opposite will be the case." JOSEPH STEWART.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Engine Room Problems

How would you find the pressure at which to set a relief valve on the receiver of a cross compound condensing engine? Boiler pressure is 130 lb.

2. What mechanical action takes place in an inertia governor when the load is changed from light to heavy?

3. How would you find the mean diameter of a corrugated furnace?

4. How are gridiron valves balanced?

5. Forty-two thousand is the shearing strength of rivets in single shear. Why are not rivets in double shear allowed 84,000 instead of 78,000? F. H.

A. Seaton says that the receiver pressure should never exceed half the boiler pressure, so the relief valve should be set at half the boiler pressure. This pressure, however, is above what is considered good working pressure for the receiver; but that will allow for some flexibility in the operation of the engine.

In the operation of a compound engine, it is customary to have about the same number of expansions in the high and low-pressure cylinders; this makes the load carried by each cylinder the same. In your case, we will consider that you carry a 20-in. vacuum. This is practically 5 lb. absolute pressure; your initial absolute pressure is practically 130 plus 15 = 145 lb. The total number of expansions is 145 divided by 5 = 29. The number of expansions in each cylinder is found by extracting the square root of this, or

$$\sqrt{29} = 5.39.$$

The exhaust pressure of the high-pressure cylinder then would be 145 divided by 5.39 = 27 lb. nearly. This would be a reasonable pressure to carry in your receiver. If you wish to increase the load on your low-pressure cylinder, it is necessary to increase the receiver pressure; to allow for this flexibility, the relief valve is set considerably higher than you would ordinarily care to carry in the receiver.

2. In regard to your question on the inertia governor, refer to an article on "Adjusting the Rites Governor," which appeared in Jan. 1, 1913, issue of Practical Engineer on page 80.

Answering your question direct, however, when the speed is uniform the flywheel and governor weights rotate at exactly the same speed; when a load comes on the engine, the flywheel lags a trifle in speed; but the inertia of the governor carries it ahead at its former speed and this relative motion with the flywheel lengthens the cutoff, thus giving the engine more steam and bringing its speed up to normal. A decrease of load on the engine will allow the flywheel to advance in speed, but the inertia of the governor tends to hold it at its former speed; this relative motion shortens the cutoff, thus decreasing the speed until it becomes normal.

3. The mean diameter of a corrugated furnace is the average of the minimum and the maximum diameter, which is usually the minimum diameter plus 2 in. The mean diameter can, however, be found by the following formula:

$$D = (C \times T) \div P,$$

where D = Mean diameter in inches.
C = 15,600, a constant obtained by tests.
T = thickness in inches.
P = pressures allowed in lb. per sq. in.

4. The construction of gridiron valves is such that they can be only partially balanced, in this case the balancing plate has ports which are directly over the ports to the cylinder, while the valve slides between the pressure plate and the valve seat. Thus all the pressure that is placed upon the valve acts on an area equal to the port space and then only when the steam ports are not open.

5. From various tests and experiments, the shearing strength of rivets in double shear has been found to be 78,000 lb.; when in single shear, the strength was 42,000 lb. per sq. in., so in calculations we use the value found by experiment. R. E. T.

Trouble with Wattmeter

In the plant where I am employed we have a Westinghouse low-pressure turbine connected to a 440-v., 3-phase, 60 cycle, 3600-r.p.m., alternating-current generator. Connected to one of switchboard panels of this generator is a Crocker-Wheeler synchronous motor of 10 poles, 440 v., 3 phase, 60 cycle, 720 r.p.m., driving an 8-pole, interpole type, 720-r.p.m., 250-v., compound wound, direct-current generator. The synchronous motor is excited from this generator and builds up as an induction motor until in step with the generator, and then runs in synchronism with it.

Whenever the motor is running and builds the power factor up on the generator, the wattmeter runs backward; but when the power factor remains about normal (80 per cent), the wattmeter runs right. The wattmeter is a Westinghouse polyphase integrating meter and I should like to know what causes the change in rotation when the synchronous motor is building up the power factor. N. H. H.

A. It is apparent from your question that your wattmeter is either defective or else connected up wrong. As the synchronous motor is being driven by the generator, it follows that, regardless of power factor, the generator is supplying power to the motor, and the meter would naturally have to run forward.

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A polyphase wattmeter consists of 2 ordinary single-phase wattmeters with a common shaft. If 2 single-phase wattmeters be used to measure 3-phase loads, the following things will be noted: At 100 per cent to more than 50 per cent power factor, both meters run forward; at 50 per cent power factor, one meter runs forward, while the other stands still, and at less than 50 per cent power factor, one meter runs forward, and the other runs backward more slowly. Thus we note that for one meter the rotation is forward regardless of power factor, while the second meter runs forward or backward, depending on whether the power factor is above or below 50 per cent.

From this it would seem that possibly one element of your meter is not working, or is out of the circuit through a blown fuse or loose connection.

To check for proper direction of rotation, proceed as follows: (A) With normal power factor, say 80 per cent, open potential circuit of lower element. Meter should run forward impelled by upper element alone. If it does not, reverse either potential or current leads.

(B) Reconnect potential to lower element, and open potential circuit of upper element. Lower element should cause meter to run forward; if it does not, reverse either current or potential leads.

As a check on above, after meter has been reconnected: (A) Open potential circuit of lower wattmeter element. Note direction of rotation, i.e., when starting. Replace potential circuit on lower meter element and open potential circuit of upper element. This lower element should cause disk to rotate opposite from the direction due to upper disk. While making this check, note which element runs faster, the forward or the backward rotating one. Having determined this, arrange connections so that the faster element runs forward and the slower element backward.

Care should be taken to connect according to the manufacturers' diagram, being sure that current and potential from the same phase go to the same element of the meter. An easy check for this when current and potential transformers are used and secondary leads run through pipe so as to make tracing out of circuits difficult, is the following:

Select a current and potential transformer on the same primary main. This ought not to be difficult to trace out, as this part of the wiring is generally quite exposed. Pull the fuse or in some other manner open the potential circuit. Short-circuit the current transformer terminals and open the secondary lead beyond the short.

If the meter runs, connections are correct, as there is still one element properly connected. If the meter stops, this indicates that the wrong set of potential leads is being used with a given set of current transformer leads, as evidently both elements of the meter have stopped. This could be due only to having opened the potential circuit on one and the current circuit on the other.

V. E. JOHNSON.

TACKLE THE WORK just in front of you. Strive in an honest way to do the best you can, and if, having done your best, there seems to appear the hand of some overruling Power which hammers you, take it like a good piece of steel and come right off the anvil with a better temper and a keener edge.

C. W. POST.

Electrical Questions

How DOES an induction motor differ from other motors?

2. How does a motor without commutator and brushes operate?

3. What constitutes a cycle in motors and generators?

4. Please describe phase and frequency. J. S.

A. 1. & 2. Induction motors operate on the principle that the current in the rotor, instead of being led in by means of brushes and commutator, is "induced" by the current in the stator. Hence, generally speaking, no commutator or brushes are needed.

Whenever current flows in a coil, a magnetic "field" or stress is produced in the surrounding air. A change in direction or intensity of flow of the electric current produces a corresponding change in the magnetic field. Now, if another closed coil of wire be brought into this magnetic field, any change of the field will result in the flow of current in this coil. In this way, when current in one coil changes in direction or intensity of flow, there is "induced" a secondary current in any adjacent closed coil.

Alternating current, or a current regularly varying in direction and intensity of flow, is impressed upon the stator of an induction motor in such a manner that a "revolving field" is produced. In other words, the effect is the same as if alternate north and south magnetic poles were revolved regularly about the circumference of the rotor. The tendency of the coils in the rotor is to follow this revolving field, resulting in the revolution of the rotor.

3. An alternating current is one that reverses its direction at regular intervals, gradually decreasing from a maximum amount in one direction to zero, then increasing to an equal maximum in the opposite direction, etc. The variation from maximum in one direction through zero to maximum in the other direction, then through zero to maximum in the first direction, is called a cycle.

4. In most alternating current motors, there are 2 or 3 circuits in the armature of motor and generator. Though these are interconnected and may deliver current to interconnected transmission lines, they set up separate currents, which are not in time with each other.

For a 2-phase machine, the currents will be a half cycle apart, or else a quarter cycle apart; while for a 3-phase circuit, the currents will be ⅓ of a cycle apart.

Frequency relates to the number of cycles per second. For instance, in the case of a current changing direction 120 times per second, since there are 2 reversals in direction per cycle, the frequency is 60 cycles.

W. N. S.

Questions on Boilers, Pumps and Engines

WHAT IS meant by the maximum capacity of a boiler?

2. Why is it better to have a boiler suspended on hangers than on lugs?

3. When inspecting a boiler, how would you determine which braces had the most strain on them?

4. What is a fire crack? Is it dangerous? What would you do if you discovered one?

5. What precaution should be taken when cleaning a boiler located in a battery?

6. Where should your feed line enter an Ohio standard boiler?

7. Is the pressure the same on all parts of a boiler?

8. How many pounds of coal would it take to heat 200,000 lb. of water from 60 to 180 deg. F., efficiency of boiler 70 per cent, coal containing 11,000 B.t.u.?

9. What is meant by T. S.?

10. Why is a narrow strap placed on the outside of a butt joint and the wide strap on the inside?

11. How many gallons of water would be delivered by an 8 by 10 by 12-in. high-pressure pump making 100 strokes per min., piston rod being 3 in. in diameter?

12. What kind of a pump is the most economical?

13. What would you do to remedy the jarring of a pump and feed line?

14. Is vacuum power?

15. What is high rotative speed? What is high piston speed?

16. What closes the admission valves on a 4-valve engine?

17. How would you set the valve of a slide valve engine?

18. Is a common slide valve a balanced valve?

17. In keying an engine, the keys being inside of the pins, how does it affect clearance? Does it lengthen or shorten the connecting rod?

18. If steam entered a cylinder at 300 deg. F. and exhausted at 200 deg. F., to what would the fall in temperature be due, since it is not due to radiation?

19. Find horsepower and constant of an engine the diameter of whose cylinder is 10 in., stroke 12 in., 200 r.p.m.

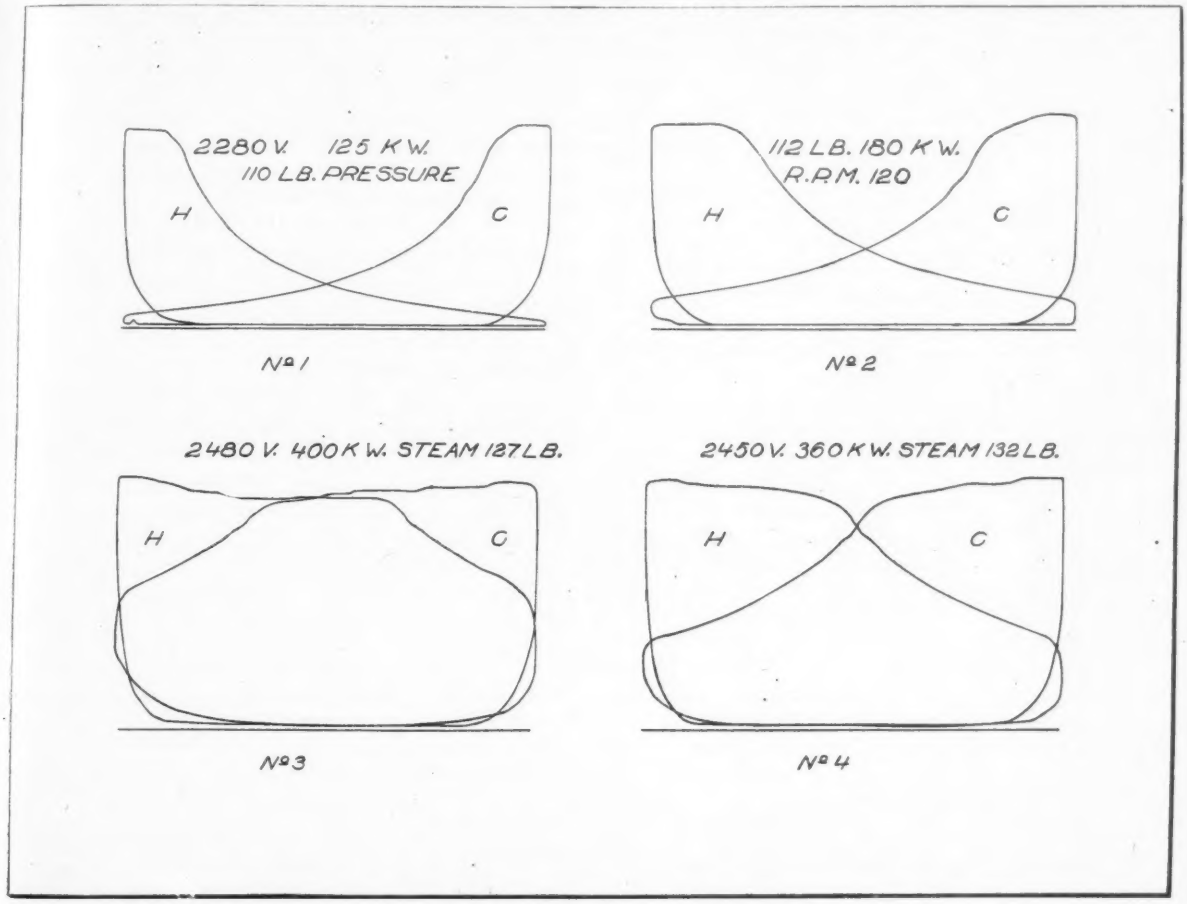
20. If the crank was moved 90 deg. from the center, from what center would the piston displacement be the greatest?

OTTO H. DREYER.

Good Engine Performance

HEREWITH ARE sent indicator cards taken from an Allis-Chalmers Corliss engine, of the 2 eccentric, long range cutoff type, 20 by 36-in. cylinder, running at 120 r.p.m., and designed for 125 lb. pressure. I understand it is rated at 480 hp. Can anyone suggest a way to better the running of this engine?

M. C. M.



CARDS FROM ALLIS-CHALMERS ENGINE

PROGRESS IN reinforced concrete construction has been rapid, each year leaving last year's best efforts far behind. The latest and largest building of this type is a 17-story structure for the Robert Gair Co. of Brooklyn, N. Y., 275 ft. from roof to curb, the main building having 12 stories 200 by 125 ft. and the tower 5 additional floors 50 by 50 ft. This is the latest of a group of structures erected for this company comprising 2 of 7 stories, 3 or 9 stories, 1 of 12 stories, and this latest and tallest 17-story.

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Fate of the Good Plant

A 30,000-hp. steam plant is quite a big and expensive undertaking, and naturally we would like to have plants of such size endure for many years. But in this day of rapid betterment a new plant is often old in 5 yr. Mechanically, our modern plants are durable and work well for several times 5 yr., but economically they soon become back numbers. The enormous power plant of the Interborough Rapid Transit Co., New York City, is one of the most recent examples. A comparatively new plant has there been replaced by a newer and still better and larger one.

An engineer who is installing a 30,000-hp. plant in the East takes great pride in his design, plant layout and machinery selection, choosing the latest, best and most efficient machinery. But this man is far-sighted enough to know that the excellence of his plant will be only temporary. "Five years from now," he says, without evidence of regret, "it will be an out-of-date plant according to the present rate of development in power plant improvement. Ten years from now I expect to see most of these now highly efficient machines sold to the scrap dealer, or relegated to stand-by use only."

As long as engineers look at it in this light, and as long as it is true, we may be sure that conditions in the power plant field are in a good healthy state.

Standardizing Boilers

At the recent meeting of the American Society of Mechanical Engineers, there came up for discussion the revised report of the Committee on Rules for Boiler Construction and Operation. In the past, committees of this society have done a great amount of valuable work in codifying the standards which have been adopted by manufacturers and engineers, working toward safe practice and uniformity in machinery. While it is desirable, in some instances, to have special machines to fit special needs, for the great majority of cases, a reasonable range of standardized machines will serve practically as well, with much less expense to both manufacturer and user, and with greater satisfaction in delivery, upkeep and repairs.

Examples of these codes are the shafts and bases for direct connected generating units, methods of testing boilers and engines; and now the most important and difficult work of all, the standardizing of construction for tubular boilers, and of installation for all kinds of boilers, is practically completed. In this work, the society has had the cooperation of practically all the manufacturers in the country, and has lent its influence to nationalize many of the excellent rules which have been worked out by the Massachusetts Board of Boiler Rules, and modified, from time to time, as experience proved wise.

While the committee report does not become binding on anyone, it is likely to be accepted by all states and cities which in the future pass rules for the governing of boiler construction and inspection, and the moral influence will be likely to cause its adoption by all manufacturers of boilers. To the credit of these manufacturers, it is to be said that for years they have been endeavoring to bring about the adoption of uniform

standard specifications, but have been hampered by the diversity of ideas among boiler buyers and the legislating bodies who have made the boiler rules for different communities.

We believe everyone who has examined the committee report will agree that it is a most commendable as well as monumental piece of work, and the power plant industry, both makers and users, are to be congratulated on having this task completed, and the society is due to receive a hearty vote of thanks for its services in bringing about such a satisfactory result.

The report will probably be available for general distribution within a few months, but exactly what arrangement will be made for supplying it has not yet been made known by the Society.

News Notes

THOSE WHO ARE DESIROUS of having tests made on high pressure apparatus will be interested to know that Joseph Tracy, of 790 Broadway, N. Y., is providing facilities for tests with saturated or superheated steam up to 480 lb. pressure per square inch.

ON SUNDAY, Nov. 29, Charles Hopper, who has been associated with the Keystone Lubricating Co., died at his home in Philadelphia, Pa. Mr. Hopper had a host of friends in the power plants of the country, due to his long experience in the field and his untiring activity in making successful the many conventions of engineers which he attended, both as delegate and as a prominent officer of the Exhibitors' Associations.

A. E. SEELIG, who for several years has been associated with the L. J. Wing Mfg. Co., and recently was Manager of the Machine Tool Department in the New York office of Schuchardt & Schutte, has been appointed General Sales Manager of the Kerr Turbine Co., Wellsville, N. Y. Also, John A. Hense, formerly with the National Malleable Castings Co., of Chicago, and later with Dravo-Doyle Co., of Philadelphia, becomes St. Louis representative of the Kerr Turbine Co.

U. S. CIVIL SERVICE COMMISSION announces an examination, Jan. 5, 1915, for gas waste engineer, to fill a vacancy in the Bureau of Mines, Department of the Interior, for service in the field, at a salary ranging from $2400 to $3600 a year. Duties will be to investigate the production, transportation, distribution and utilization of natural gas, with particular reference to the waste of natural gas and the suggestion of corrective methods that will eliminate this waste. It is desired to procure the services of persons with a broad technical and practical engineering experience in natural gas and related petroleum industries. Competitors will be rated on the following subjects, which will have the relative weights indicated: Education, 30; experience, 50; publications or reports, 20. Graduation in mechanical engineering from a college or university of recognized standing and at least 10 yr. practical experience, covering the development, production, transportation, distribution and utilization of natural gas, are prerequisites for consideration for this position. Under the third subject, professional reports may be submitted in lieu of or in addition to publications. Applicants must have reached their thirtieth but not their fiftieth birthday on the date of the examination. Persons who desire this examination should at once apply for Forms 304 and 2095, giving the title, Gas Waste Engineer, Male, to the U. S. Civil Service Commission, Washington, D. C.

IN LAYING out shafting for transmission lines, the following data, given by H. C. Stillman will be found convenient:

Hangers for different diameters of shafting should have the spacing between centers of bearings approximately as follows: For 15/16-in. shaft, 5-ft. centers; for 1 7/16-in., 6 ft. 3 in.; for 1 15/16-in., 8 ft.; for 2 7/16-in., 9 ft.; for 2 15/16-in., 10 ft.; for 3 7/16 in., 11 ft.; for 3 15/16-in., 12 ft. Bearings should have a lining of good babbit metal, with a length not less than 4 diameters of the shaft, and should have ample provision for lubrication, such as ring or chain oiling. The vertical adjustment of frames or hangers should be at least 2 in., to take care of the alinement of the shaft. Split collars should be used with safety set screws to prevent endwise shifting, and not less than 4 collars on each shaft, so that the shaft will not shift in case one of the collars becomes loosened.

In order to avoid abnormal strain, the following relations of pulley to belt should be observed: For single-ply belt, a minimum pulley diameter of 3 in., and the ratio of diameter to width is not important; for double-ply belt, 6 in. minimum diameter, and the diameter never less than ¾ of the width of the belt; for triple belt, 10 in. minimum diameter, with the diameter never less than the width of the belt. Pulleys should be kept as large as possible, in order to increase the belt speed; but this should not exceed 4000 ft. a min., as above that the centrifugal force interferes with the contact between the belt and pulley. The pulley should be made 20 per cent wider than the belt which is carried.

What kind of belting to use, is often a problem, and the following rules will be found helpful: For high-speed machines, a single belt is best, or if the pull is quite heavy, a light, double belt. For slower speeds, a double belt should be used, or for heavy pull, a triple. Sometimes for a heavy pull, a double belt with the edges sewed, will stand up better than a triple. If there is danger of moisture, a waterproof belt should be used. Some classes of work may be listed as follows: For motor drive, use a light, double belt; for pulleys 12 in. or wider, use double belt, and for pulleys 48 in. or over, triple belt. All main drive belts should be heavy double, but quarter twist belts should be made as narrow and as heavy as possible. High-speed machinery, such as woodworking machines, fan-blowers, etc., should take single or light double belts, and for flange pulleys, use the light double. A single belt should never be used with a belt shifter. Where the temperature is over 120 deg., a special tan should be used, intended for high temperatures. Where belts run at 2500 ft. a min. or over, the pulley should have but a slight crown, as a heavy crown causes the edges of the belt to rise from the face of the pulley, reducing the contact and driving power. Flanged pulleys should be avoided where possible, and where necessary, the flanged pulley should be 2 in. wider than the belt.

XUM

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Core-Loss Testing Outfit

AN outfit used for determining the hysteresis and eddy losses of sheet iron and steel, the core loss being read directly on a wattmeter, has been recently introduced. The complete equipment consists of a specimen or sample holder, a frequency meter, ammeter, voltmeter and wattmeter of suitable capacity to make the required measurements. The sample holder, consists of 4 solenoids mounted along the sides of a square wooden base, in such a way that, when the test pieces are placed in them, a continuous magnetic circuit having 4 equal sides is formed, the corners of this circuit being held firmly down by means of a 4-jawed clamp worked with a toggle-joint mechanism at the center. (See Fig. 1.) This insures equal pressure at all 4 corners and also insures the same pressure being exerted each time a test is made. This method of clamping eliminates the personal equation and a saving in time is also effected. Each of the 4 coils

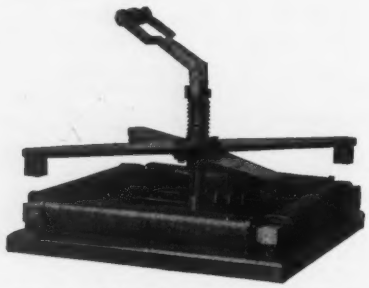


FIG. 1. TOGGLE-JOINT MECHANISM FOR CLAMPING SAMPLE

has a primary and secondary winding. The 4 primaries, one on each solenoid, are connected in series and the ends are brought out to terminal posts. The secondaries are arranged in the same manner. The coils are wound on micarta tubes and a layer of cotton tape is wrapped around the outside. All wooden parts are black lacquered, while the toggle-joint handle and terminal posts are nickel plated. A pedestal for mounting this sample holder is also furnished if desired.

The procedure of test as herein outlined is that recommended by the American Society for Testing Materials. The scheme of connections used is that shown in Fig. 2.

The material to be tested is made up of strips, about 1.2 by 19.7 in., divided into 2 portions, 11 lb. each, one cut parallel to and one at right angles to the direction of rolling. Each portion is divided into 2 equal parts by balancing against each other, and each bundle is tied together with string or tape (not wire) and inserted in the solenoids, the 2 halves of the same portion being placed on opposite sides. A piece of tough paper (0.004 in. thick) should be inserted in the joints at the corners. An alternating voltage should then be applied to the primary winding and the corners of the magnetic circuit tapped together with the tapping block, which is furnished with the outfit, until the current has a minimum value, as shown by an ammeter in series. The corners are then firmly clamped by means of the toggle-joint. The ammeter is shunted and the primary voltage adjusted until the voltmeter in the secondary circuit reads the standard value. This adjustment can be made by means of an auto-transformer, by varying the field of the alternator, or both, and not by inserting resistance or inductance in the primary circuit. Similarly, the frequency must be adjusted to 60 cycles. The watt-

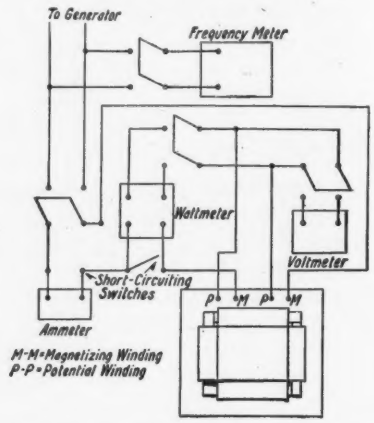


FIG. 2. DIAGRAM OF CONNECTIONS

meter is then read and the instrument losses, which will be constant at any one voltage and for any set of instruments, subtracted. The result divided by 10 equals the loss in watts-per-kilogram or standard core loss.

The outfit described above is made by the Westinghouse Electric and Manufacturing Co.

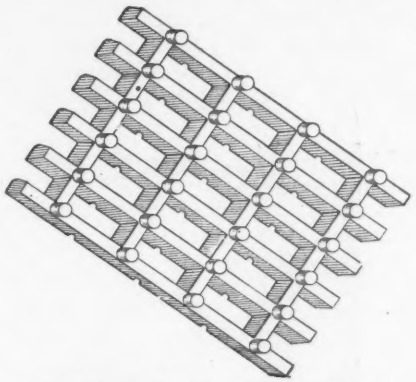
Grease Retarder for Open Slots or Wells

ON large bearings where grease wells are formed in the top cap, lubrication has been effected in one of 3 ways; by placing a heavy grease in the well directly on top of the journal; by means of wool or cotton waste saturated with oil; or by feeding grease to the center of the well by means of a grease cup.

The first method is wasteful, as the grease grinds away rapidly, especially where there is considerable

clearance between the top cap and the journal. The second is subject to the tendency of oil to flow rapidly out of the bearing and its inability to stand the heavy pressure which such bearings usually carry. When the third method is used, if the grooves are not cut directly in the line with the center of the bearing, part of the journal is without lubrication. Retarders made from copper wire gauze, perforated copper plates, perforated wood or leather have been used with grease, but none of these have been entirely satisfactory.

These difficulties usually experienced in lubricating such a bearing have been overcome by the use of the Keystone babbit metal retarder, which is bent to conform to the curve of the journal and is made slightly smaller than the grease well in width and length, the grease being placed on top of the retarder in the usual manner.



KEYSTONE BABBIT METAL RETARDER

The under side of the retarder is grooved and one edge of each bar is rounded so that the grease wedges between the retarder and the journal instead of being scraped off. The grease is spread over the entire bearing surface and fed into every groove in the bearing cap; but all waste is prevented, providing efficient and economical lubrication. This retarder was devised by Thomas O. Organ, consulting engineer of the Keystone Lubricating Co., of Philadelphia, Pa.

New Automatic Solenoid Brake

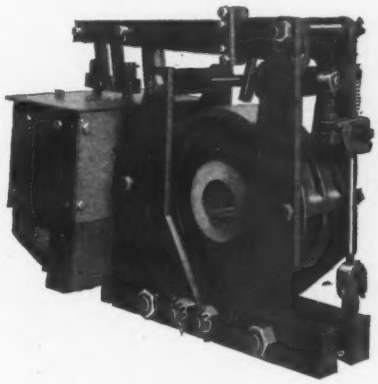
A NEW automatic solenoid brake for crane, hoist, lift bridge and similar service has recently been developed and placed on the market by the General Electric Co. The operating force of this brake is transmitted to the free or top ends of the yokes through horizontal levers, which are attached to the movable element of the solenoid by means of links. When the solenoid is energized, the movable element is forced up to the end of its travel, releasing the brake, and when the coil is demagnetized, the brake is set by gravity.

In sizes below 50 hp., the brake has a box type of frame, which is attached to bosses on the motor frame. Cast yokes are employed in this type, but in other respects the brake is similar to that for motors of capacities of 50 hp. and above. All these designs may be modified to suit the requirements of such special applications as lift bridges, printing presses, etc.

The brake has 3 unique features: automatic solenoid air-gap adjuster, automatic shoe clearance adjuster, and floating top core type of solenoid.

The solenoid air-gap adjuster is designed to maintain constant the distance between the upper, or floating, and the lower cores of the solenoid when the brake is on and all necessary adjustments can be made by means of a ratchet wheel, pawl and adjustment rod shown in the illustration. The pawl is so designed that when the air-gap in the solenoid—i. e., the distance between the upper and lower cores—increases beyond a certain value, the pawl will engage with a tooth of the ratchet wheel and rotate it slightly when the movable element of the solenoid is forced up by the magnetic field of the latter to release the brake. This shortens the air-gap in the solenoid slightly, with the result that the movable element does not drop far enough when the brake is set for the pawl to engage the ratchet wheel again until the shoes wear sufficiently to permit it. One tooth on the ratchet wheel corresponds to a slight variation in the distance between the upper and lower solenoid cores, so that the adjustment is very close.

In the shoe clearance adjuster, a rod attached to one of the base bars passes through a bracket bolted to one of the yokes, which bracket has a slot for a spring clamp attached to the rod. As the shoes wear, allowing the yokes to approach slightly nearer to the wheel when the brake is set, the spring clamp is moved up correspondingly by the bracket, these 2 parts being in contact when the brake is on. As soon as the brake is released, the right-hand yokes move back under the influence of gravity and the spring until the set-screw strikes the spring clamp. Thus, the distance between these 2 positions of the shoes—i. e., the shoe clearance—is maintained constant.



SOLENOID OPERATED BRAKE

The braking effect may be increased by changing the lever pin to one of the other sets of holes designed for it, and also by removing one or more of the weights on the movable element of the solenoid.

An oil dashpot, single-acting in the downward direction, is supplied with the larger sizes to prevent any rebound of the movable element of the solenoid at the instant of setting the brake, thus giving a smooth application. The dashpot effect may be varied; but all dashpots are correctly adjusted at the factory, using an oil that is little affected by changes in temperature.

XUM

With respect to direct-current brakes, a series wound coil is standard for crane work. All standard series brakes release on 40 per cent of rated full load current of the motor to adapt them to dynamic braking. There are special applications which require a shunt winding, as, for instance, bridges where the motor coasts with the current off and brake released.

Alternating-current solenoids are shunt connected. Coils for such high potentials as 2200 v. and frequencies ranging from 25 to 60 cycles, can be furnished, if desired. These are single-phase and therefore suitable for single, 2 and 3-phase circuits without change. Pole shading rings are inserted in the face of the solenoid core at the air-gap surface in order to insure practically noiseless operation.

All wheels are cast steel, are perfectly balanced, and those for the mill type of motors and alternating-current crane and hoist motors are taper bored to facilitate the removal thereof. They are of small diameter so as to have small flywheel effect, and of wide face to insure ample wearing surface. The brake is so designed that the wheel cannot drop off even though it may accidentally work loose.

The solenoid coil is connected to the controller so that when the latter is thrown to the "on" position, the movable element of the solenoid is raised, thereby releasing the brake and allowing the motor armature to revolve freely.

When the controller is thrown to the "off" position, or when the power fails, the movable element drops, thus causing the brake to set and hold the motor armature from turning. In special cases, as, for instance, in the service on a lift bridge, where the brake and motor turn through an angle, the brake is set by means of a spring, which assures constant braking effect at all angles.

Use of Cylinder Lubricants

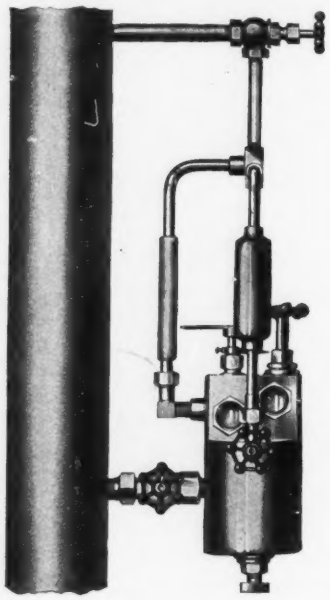
PRACTICALLY all cylinder lubricants have as their chief base some product derived from petroleum, hence a short consideration of this valuable substance is of interest.

The name is from 2 Greek words, "petros," meaning a rock, and "oleum," oil, giving as a meaning rock oil. It is found in practically all parts of the earth, some places in large quantities, others but a small supply. It has been known since early ages, but until 1858 was not largely used. At that time, Col. Drake discovered the rich American supply near Titusville, Pa., and development started.

Petroleum is a hydro-carbon of complex composition, varying greatly in different localities, and having greater or less proportions of nitrogen, oxygen and sulphur. In refining, distillation is used, accompanied by chemical treatment, in order to separate the oil into the parts of different body and viscosity, and to get rid of oxygen, sulphur and other undesirable elements.

In distillation, the crude oil is heated by steam in large tanks, and time allowed for dirt and solid matter to settle out. The oil is then put into the still and heated to different temperatures, vapors leaving in the order of their density and being passed through a condenser, then into different tanks according to the product desired. The usual divisions are 5, napthas, burning oils, lubricating oils, paraffine wax and coke, each of which is refined and subdivided for special uses. Cylinder stock is one subdivision of the lubricating oils near the heavy end of that division, and must be secured with great care to retain all the valuable lubricating properties.

After distillation, the cylinder stock is strained to take out gritty matter, sometimes refrigerated to take out any possible paraffin and then is ready for the market as "Dark or Steam Refined Cylinder Stock." In some cases, it is also filtered through charcoal to give it a lighter color, and it is then known as "Filtered or Extra Filtered Stock." These stocks are heavy and thick, in fact, cannot usually be poured from a bottle unless heated; they have high fire test and viscosity, and from them are obtained vaseline and petroleum jelly.



LUBRICATOR FOR FEEDING CYLINDER GREASE

In making cylinder oils, these stocks are compounded with percentages of neutral oils, animal oils or fats, and sometimes vegetable oils, the quality of the resulting cylinder oil depending on the ingredients and the proportions used. Neutral oils are obtained from the light lubricating oils, having about 200 deg. lower fire test than cylinder stocks, and are used to thin down the cylinder stocks, so that the resulting oil may be handled in the ordinary manner.

Animal oils used are tallow, lard, neatsfoot and degras, or wool fat, all of which solidify at comparatively high temperature and are of slightly higher fire test, though not so high in viscosity as neutral oils. They are used to assist the cylinder oil in withstanding the action of the water in steam.

Cylinder grease, which has been developed to its present state of perfection by the Ohio Grease Co., of Loudonville, Ohio, is prepared from the best cylinder stocks obtainable, compounded with a small percentage

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

XUM

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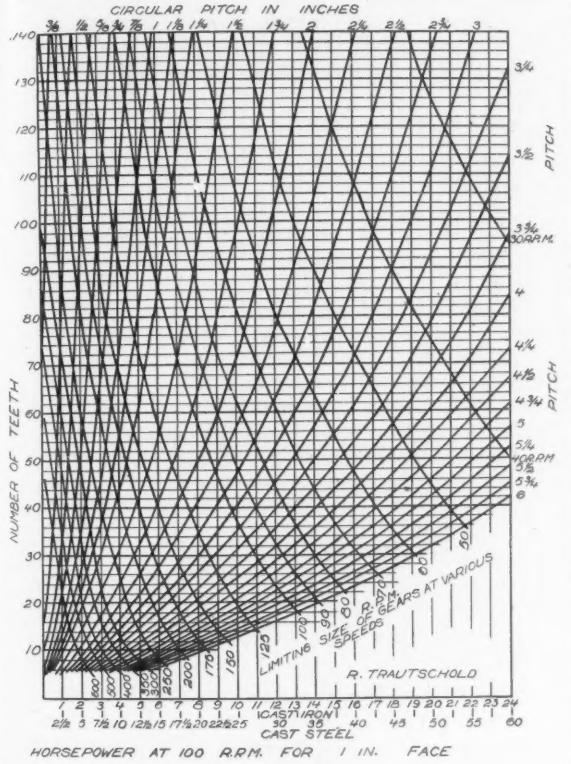
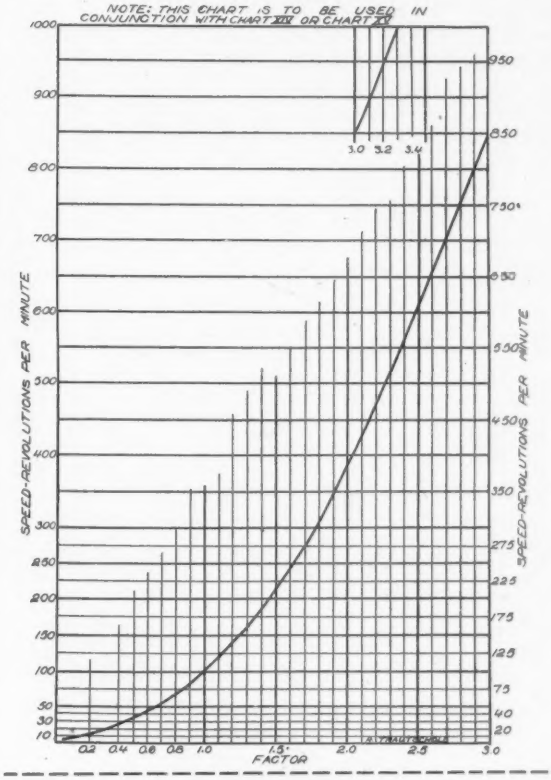
CHART XIV. HORSEPOWER OF SPUR GEARS, CAST TEETH



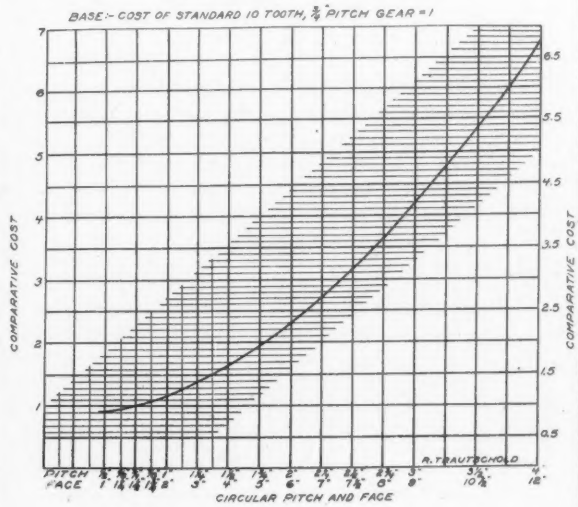
PRACTICAL ENGINEER

CHART XVI. HORSEPOWER FACTOR FOR SPUR GEARS AT VARIOUS SPEEDS


NOTE: THIS CHART IS TO BE USED IN CONJUNCTION WITH CHART XIV OR CHART XV
SPEED-REVOLUTIONS PER MINUTE
FACTOR
R. TRAUTSCHOLD

PRACTICAL ENGINEER

CHART XVIII. COMPARATIVE COST OF STANDARD CAST-IRON SPUR GEARS, CAST TEETH



PRACTICAL ENGINEER

CHART XX. SPECIAL CHARGE FOR SPUR GEAR FACE WIDTH OTHER THAN STANDARD, ADDITIONAL TO COMPARATIVE COST OF GEARS OF STANDARD FACE

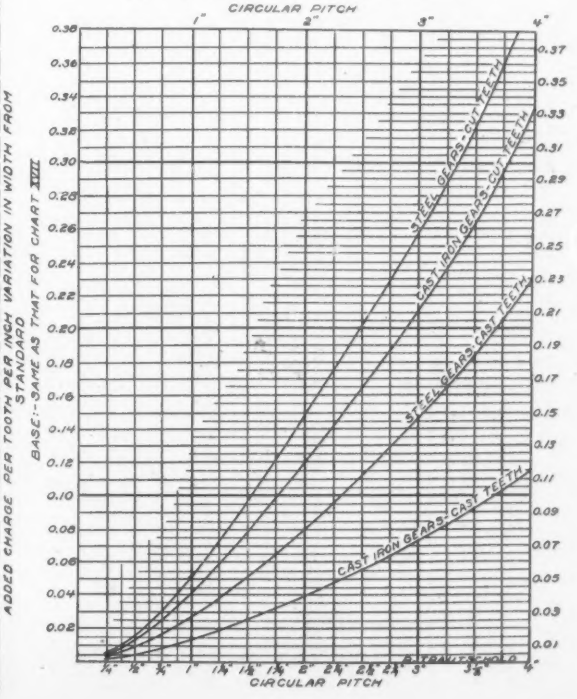

CIRCULAR PITCH
ADDED CHARGE PER TOOTH PER INCH VARIATION IN WIDTH FROM STANDARD
BASE:- SAME AS THAT FOR CHART XVIII
STEEL GEARS-CUT TEETH
CAST IRON GEARS-CUT TEETH
STEEL GEARS-CAST TEETH
CAST IRON GEARS-CAST TEETH
R. TRAUTSCHOLD

CHART XVII. PROPORTIONAL COST OF STANDARD CAST-IRON SPUR GEARS, CAST TEETH

NOTE:- THIS CHART IS TO BE USED IN CONJUNCTION WITH CHART XVIII TO ASCERTAIN COMPARATIVE COSTS OF STANDARD SPUR GEARS.
PROPORTIONAL COST. BASE-COST OF STANDARD 10 TOOTH GEAR=1.
R.TRAUTSCHOLD
NUMBER OF TEETH

CHART XV. HORSEPOWER OF SPUR GEARS, CUT TEETH

COMPARATIVE GEAR COST SUMMARY

Case A, Cast-iron, Cast teeth; 2-in. pitch; 7-in. face

No. Teeth	Chart Factor XVII	XVIII	XIX	Cost Std. Width	Extra Width in.	Factor Chart XX	Cost Extra Width	Total Cost One Gear	Total Cost Both Gears
54	6.0	x 2.3	x 1 = 13.80		x(7 - 6)	x 0.395 = 2.13		15.93	
54									
27	2.75	x 2.3	x 1 = 6.33		x(7 - 6)	x 0.395 = 1.06		7.39	23.32
27									

Case B, Steel, Cast teeth; 1½-in. pitch; 3½-in. face.

86	6.3	x 1.4	x 2 = 17.64		x(3.5-3)	x 0.38	= 1.63	19.27	
86									
43	2.9	x 1.4	x 2 = 8.12		x(3.5-3)	x 0.38	= 0.82	8.94	28.21
43									

Case C, Cast-iron, Cut teeth; 1½-in. pitch; 3½-in. face.

140	12.7	x 1.4	x 2.1= 37.34		x(3½-3)	x 0.59	= 2.07	39.41	
140									
70	4.9	x 1.4	x 2.2= 15.1		x(3½-3)	x 0.59	= 1.03	16.13	55.54
70									

Case D, Steel, cut teeth; 7/8-in. pitch; 2½-in. face.

140	9.6	x 1.1	x 3.1= 32.74		x(2½-1⅞)	x 0.4	= 2.80	35.54	
140									
70	3.6	x 1.1	x 3.2= 12.67		x(2½-1⅞)	x 0.4	= 1.40	14.07	49.61
70									

CHART XIX. RELATIVE COST OF STANDARD SPUR GEARS, CAST-IRON AND STEEL, CAST OR CUT TEETH

BASE-COST OF CAST IRON, CAST TEETH, GEARS=1
STEEL GEARS - CUT TEETH
CAST IRON GEARS - CUT TEETH
STEEL GEARS - CAST TEETH
CAST IRON GEARS - CAST TEETH
RELATIVE COST
NUMBER OF TEETH
R.TRAUTSCHOLD

of acidless tallow and other high grade ingredients, the object being to solidify and intensify or concentrate the ingredients making up the product.

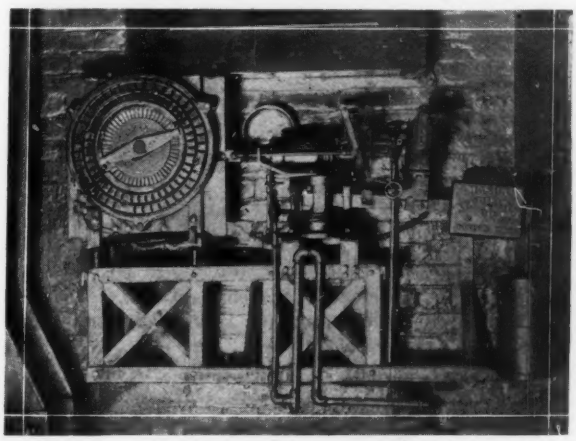
In order to apply this lubricant to the best advantage, the company has devised a lubricator, which supplies the grease in atomized form, delivering it to the steam as a fine spray, so that it is mixed intimately with the steam and deposited equally on all working surfaces, thus giving uniform lubrication. This instrument is made in both up-feed and drop-feed styles, and is furnished without charge by the company for feeding cylinder grease.

Electric-Driven Pump Speed Control by Pressure Regulator

DESCRIBING the arrangement of Mason apparatus that took second prize in the photographic contest, Geo. Van Vlack, of Rochester, N. Y., says:

"Some years ago, the writer installed the device shown in the accompanying photograph in the boiler room of the State Industrial School in this city, and it has saved its original cost many times over.

"The device consists of a Mason pressure regulator of the ordinary type, connected to a Cutler-Hammer changeable speed rheostat, controlling the speed of a 35-hp. Fairbanks-Morse d.c. motor, driving a 9 by 10-in. Deming triplex boiler feed pump.



MASON REGULATOR CONTROLLING SPEED REGULATOR FOR PUMP

"The switch, starting box, motor and pump are on the opposite side of the brick wall and do not show in the picture.

"It has been demonstrated beyond a reasonable doubt that the efficiency of a power pump of this type is much higher than is the case with a steam-driven pump, the only possible objection being in the matter of close regulation of pressure, as is desirable in the case of feeding a battery of boilers. With this device we are enabled to keep the pressure within a range of about 3 lb., between the lowest and highest speeds. When it is taken into consideration that the speed of this motor has a range of from 300 to 900 r.p.m., I believe this to be a pretty good showing.

"An advantage of this close regulation will be obvious in the matter of pumping through an economizer.

"Previous to the installation of this device we experienced considerable trouble in maintaining anything like a constant pressure on the feed lines, and were constantly subjected to the danger of a rupture of the feed lines, due to the ever present possibility of the water being cut off, or shut down too much without slowing down the pump.

"This device is always on duty, acting in the capacity of a silent watchman on guard against the menace of an over pressure on the feed water lines."

Books and Catalogs

GEARING. By A. E. Ingham, New York, 1914. Second edition: 181 pages, 56 illustrations. Price, $2.50.

In this book, the subjects of spur, bevel, worm, spiral and helical gears are taken up in detail.

The chapter on spur gears contains a valuable feature in the form of G. B. Grant's "odontograph," both as applied to the involute and the cycloidal tooth, which by means of the accompanying illustrations renders it easily understood. In this chapter are also included numerous full-sized diagrams showing the comparative sizes of diametral pitches from 11 to 1, and the comparative sizes of circular pitches from ½ to 3 in., all of the involute shape.

Following these diagrams are tables of pitch line and outside diameters for circular pitches for cut gears of from ¼ to 4 in., in 1/16-in. intervals.

Both the theoretical and the practical considerations of bevel, worm, spiral and helical gears are well covered, giving particulars of the most approved methods of solving problems associated with the various forms of these gears. Numerical examples are given illustrating the application of data and numerous tables and charts are included from which almost the whole of the necessary particulars may be obtained without calculation.

An appendix includes a brief discussion of the trigonometrical functions of right-angled triangles and a complete set of tables of sines, cosines, tangents, and cotangents given in minutes and to 5 decimal places.

WESTINGHOUSE ELECTRIC MOTORS for Machine Tool Service is the title of a comprehensive illustrated pamphlet, with an art cover, which has been issued by the Westinghouse Electric & Mfg. Co. This book describes the electrification of a machine shop, going into detail as to the type of motor to be selected for each machine, and a recital of the characteristics of direct and alternating-current motors as applied to this work. A large number of machine tools with motor drive are shown from actual installation views. In addition to this data, there are also included a number of tables showing the relation between feeds, cutting speeds, diameters of work, etc.; relation between area of cut in square inches and cutting speed in feet per minute; and amount of horsepower required for various machines.

XUM

HOMESTEAD quarter turn plug valves are described and several styles are illustrated in the latest circular from Homestead Valve Mfg. Co., Pittsburgh, Pa.

FROM MARK MFG. CO., Evanston, Ill., comes a new circular enumerating strong points of the Mark cold drawn steel union.

A SHEET of specifications for electrical conduit, together with several booklets dealing with the subject of "Buckeye" conduit, has been received from The Western Conduit Co., Youngstown, Ohio.

A. W. CADMAN MFG. CO., Pittsburgh, Pa., is sending out sheets to be inserted in its Catalog No. 5, giving price lists of the company's Tandem and Indestructible blowoff valves for a working pressure of 300 lb. per sq. in. with 5 factors of safety. These supersede all previous lists or quotations pertaining to those valves.

WESTINGHOUSE ELECTRIC & MFG. CO. has just issued Leaflet No. 3749 covering Westinghouse Synchronous Booster Rotary Converters, in which this type of apparatus is fully described and illustrated. The advantages of this type of machine are given, together with a detailed account of its method of operation and construction details. A cross-sectional view also gives a clearer understanding of its construction. A number of installation views are also shown.

A NEW BULLETIN, No. 40,500, from the General Electric Co., is devoted to the subject of alternating-current generators for direct connection to reciprocating engines. The object is to illustrate and describe some of the recent improvements in the alternators built by the company for direct connection to steam, oil and gas engines. The construction of the alternator is illustrated and described in considerable detail, and the bulletin contains data relative to dimensions, capacities, weights, etc., of alternators of this description.

LIGHT AND YOUR EYES is the title of a compact little treatise on the subject of the effect of illumination on the eye, just issued by the Cooper Hewitt Electric Co. This pamphlet contains information of interest on the subjects of the best kind of light for work, glare, and effect of red and blue rays on the eyes.

What Users of Cooper Hewitt Light Say About It, another folder just issued by this company, contains some interesting experiences given by the users of Cooper Hewitt light.

F. L. BENTON, who for the past 2½ yr. has been manager of the Chicago office of the Heine Boiler Co., has severed his connection with that company to become manager of the Chicago office of The Goulds Mfg. Co., 3801-3811 S. Ashland Avenue, Chicago, Ill., manufacturers of pumps and hydraulic machinery. Previous to his connection with the Heine Boiler Co., Mr. Bunton was for 8 yr. manager of the Philadelphia and St. Louis offices of the Allis-Chalmers Co. He is a member of the American Society of Mechanical Engineers and is well known in the machinery and allied trades.

LEO GLUCK has resigned his position as assistant to the president of the Pittsburgh Coal Co., and has opened an office as Consulting Engineer at 2420 Farmers Bank Bldg., Pittsburgh, Pa.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

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Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

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Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

ADVERTISING RATES

Display

Full page, one year, each insertion, $60.00.

Half page, one year, each insertion, $35.00.

Quarter page, one year, each insertion, $20.00.

Eighth page, one year, each insertion, $12.00.

Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Invoices are rendered monthly and subject to 2 per cent discount within 10 days.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,000.

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—As Manager or Superintendent of a steam plant of 600 k.v.a. capacity or less, where efficiency and net earnings is the slogan. Twenty-one years' experience. A1 references. Will be released about Nov. 1st. Address Box 373, Practical Engineer, Chicago, Ill. 12-15-1

POSITION WANTED—As Engineer. Can furnish best of reference. H. M. Risser, 2216 N. Tripp Ave., Chicago, Ill. 12-15-1

POSITION WANTED—As chief engineer and electrician; 25 years' experience with steam and electrical equipments, and "Diesel Engines," accustomed to the economical management of power plants and their maintenance; erecting engineering experience; good all round mechanic and electrician; age 44, married, strictly sober; best of reference; correspondence solicited. Address Leonard Miller, 100 Greenleaf St., Brownwood, Texas. 12-15-1

POSITION WANTED—As Manager or Superintendent of an Electric Light Plant or Light and Water Works plant. Fifteen years' practical experience. Seven years' successful experience as manager of light and water plant. Know how to operate economically public service plants and how to maintain same. 38 years old; married. Strictly sober. A1 references. Could begin any time. Satisfaction guaranteed. Address W. Z. Champion, 809 Austin Ave., Brownwood, Texas. 12-15-1

POSITION WANTED—As Chief Engineer of steam or hydro-electric power plant of 1000 hp. or less. 15 years' experience in central station operation; strictly temperate; best of reference as to character and ability. Middle West preferred. Address Box 376, Practical Engineer. 12-15-1

POSITION WANTED—By engineer, with first-class Canadian certificate, 14 years' experience. Familiar with any high speed, or Corliss engine; d.c. machines, air compressors, etc. Would take position as second in large power plant. Willing to go anywhere in Canada. Total abstainer. Excellent references. Address Box 378, Practical Engineer, Chicago, Ill. 12-15-1

POSITION WANTED—As Chief Engineer and Electrician; 12 years' experience as chief engineer, electrician and erector of steam and electrical apparatus. Also some refrigerating experience. Age 29. Married. Strictly sober. Can furnish best of references. Can start Dec. 15th. Correspondence invited. S. James Zucchet, 1437 Solon Place, Chicago, Ill. 12-15-1

Wanted

AN OPPORTUNITY for High Class Salesmen. A well known, established concern, manufacturing power plant specialties, wants representatives in the following territories: Syracuse, N. Y.; Louisville, Ky.; Tacoma, Wash.; Birmingham, Ala.; Raleigh, N. C.; Nashville, Tenn.; Duluth, Minn.; Cincinnati, O.; Denver, Colo. Applicants must be able to show good selling record and possess a knowledge of boiler equipment. Excellent opportunity for high class men. Details of experience and references in first letter. Box 375, Practical Engineer, Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill. tf.

WANTED—Resident subscription agents in all cities of 50,000 population, and over. Many of the largest cities still open. An excellent chance for hustlers to turn their spare time into dollars. Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Engineers who have trouble with poor circulation, foaming or priming boilers and accumulation of scale and sediment and leaky tubes to know of our sure remedy for these evils. Write for details to Olson Automatic Boiler Circulator Co., 217 Chamber of Commerce Bldg., Chicago, Ill. 10-1-6

WANTED—A few hustlers to take orders for Zinco Soot Destroyer. Quick sale. No competition. Good proposition. New York Supply Exchange, Ford Bldg., Detroit, Mich. tf.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Partner with $10,000 to invest in an established machinery business with or without services. References Bradstreets, Duns or our Bankers. Address Box 377, Practical Engineer, Chicago, Ill. 12-1-2

Help Wanted

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

FOR SALE—24x36-in., 100 revolutions, 125-lb. automatic cutoff Conway engine, right hand, shaft 18 ft. 6 in. long with two wheels 12 ft. 2 in. by 26-in. face and 11 ft. 10 in. by 20-in. face. In good condition and can be seen running any time before Nov. 1st. Built by Filer & Stowell Co., Milwaukee. Is as economical as a Corliss. Worcester Lumber Co., Ltd., Chassell, Mich. 11-1-4

250-VOLT DIRECT CONNECTED UNITS: 200 kw. Westinghouse with Harrisburg 4 valve tandem engine, $3250; 75 kw. Triumph with Erie ball engine, $900; 60 kw. Triumph with Ideal engine, $700; 35 kw. Westinghouse 3 wire with Sturtevant engine, $500; 18 kw. Sturtevant marine unit, $350. Duzets & Son, Hudson Terminal, New York. tf.

FOR SALE—25 kw. Holtzer Cabot d.c. generator with switchboard; A-1 condition. Lucas & Son, Bridgeport, Ct. 12-15-3

Patents and Patent Attorneys

PATENTS SECURED OR FEE RETURNED—Send sketch for free search, advice and report. Latest and most complete patent book ever published for free distribution. George P. Kimmel, Attorney, 226 Barrister Building, Washington, D. C. 12-15-6

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and report. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

"PATENT YOUR INVENTIONS."—Search free when patent applied for. Charles F. Kincheloe, Patent Lawyer, Woodward Building, Washington, D. C. 10-15-6

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owens, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscription (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

WANTED reliable commission selling agents in various States and also Canada to handle powder boiler compounds. Also a superior article, called "Cleaner," which can be most extensively consumed. Address James E. Dale Company, Rahway, N. J. 12-1-4

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

One week from next Friday, the benediction, "Peace on Earth, Good Will Toward Men," will be heralded from pulpits and over holly covered hearths. Our self-centered ambitions will be mellowed with a charity and good feeling for all mankind. Christmas Day and the ensuing holiday week is the time of year when the scale of selfishness is loosened from the minds of men.

This year, however, brings with the Holly, Mistletoe and Turkey the sad thought that while we of America are at peace with all men, the remainder of the Caucasian race are at war between themselves.

At the same time that we sit down to our Christmas dinner, the happenings in a thousand European locations will be animated by hatred engendered during the past year. Englishmen will chuckle with satisfaction at the true aim of their rifles; Germans will plunge their lances into their erstwhile neighboring Frenchmen with the feeling that God and their country have been served; bands of Cossacks will count the day well done as they ride the trail of fire and sword. And in Holland, France and England the homeless citizens of Belgium will endure with a far-off look in their eyes.

What is back of this sudden incompatibility of civilized mankind? Of the cause of the war, many theories have been expressed—the assassination of a nobleman—the arrogance of a monarch—the triumph of military over civil thought—the deception of an autocrat—the revenge of a feeble, senile old man—racial hatred, etc. Perhaps as is so often the case, the real cause will never be known, but among many, probably the majority of thinkers, the belief is that it is a war for commercial supremacy.

A war for commercial supremacy! We, in America, can hardly realize the possibility of such a happening. We sell our goods in peace. Why should other nations kill in order to sell their goods?

Sometimes, the editor of this page has a sort of an idea that Advertising is a big contributing factor to peace. Advertising is primarily an educational force. It creates a market where none existed before. It reasons—does not force. It fosters competition more often than it discourages it. It thrives in a "free-for-all" market—the "more the merrier."

The other idea which has been in vogue from the time of Caesar is to first conquer the country, annex it or its island possessions, or obtain a peace treaty which forces the products of the conquering nation on the vanquished. It is not to be wondered, that under such primitive ideas of trade expansion, Advertising is not extensively used as a trade factor by any of the warring countries.

And so while we enjoy our Christmas Dinner among peaceful and happy surroundings, it might be well to recall that in reading the advertisements in Practical Engineer for power plant buying knowledge, we may be aiding that educational force which will some day control the peace of the world.